PB89-125405

Ground Water Monitoring Evaluation Hughes Aircraft, U.S. Air Force Plant No. 44. Tucson, Arizona

(U.S.) Environmental Protection Agency
San Francisco, CA

Apr 88

U.S. Department of Commerce
National Technical Information Service
NTIS

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-700-8-87-037	2.	3. RECIPIENT'S ACCESSION NO. PB89 125405/AS
4. TITLE AND SUBTITLE Ground Water Monitoring Evaluation Hughes Aircraft, U.S. Air Force Plant No.44 Tucson, Arizona		5. REPORT DATE April 1988 (date issued)
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Mark G. Filippinin, Donn Zuroski		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS United States Environmental Protection Agency Hazardous Waste Ground Water Task Force 215 Fremont Street San Francisco, California 94105		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS United States Environmental Protection Agency Region 9 215 Fremont Street San Francisco, California 94105		13. TYPE OF REPORT AND PERIOD COVERED
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

see attached executive summary.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT Unlimited	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES 84
	20. SECURITY CLASS *(This page)*	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

I. EXECUTIVE SUMMARY

A. INTRODUCTION

ABSTRACT

1. Task Force Objectives

→ The EPA

This report summarizes the results of investigations conducted during April 1987 at the Hughes Aircraft/Air Force Plant #44 in Tucson, Arizona by the U.S. Environmental Protection Agency.

Operations at hazardous waste treatment, storage, and disposal (TSD) facilities are regulated by the Resource Conservation and Recovery Act. Regulations promulgated pursuant to RCRA (40 CFR Parts 260 through 265, effective on November 19, 1980 and subsequently modified) address hazardous waste site operations including monitoring of ground water to ensure that hazardous waste constituents could be immediately detected if released to the environment. The regulations for TSD facilities are implemented (for EPA administered programs) through the hazardous waste permit program outlined in 40 CFR Part 270.

The Adminstrator of the Environmental Protection Agency (EPA) established a Hazardous Waste Ground Water Task Force (Task Force) to evaluate the level of compliance with ground water monitoring requirements at commercial off-site and selected on-site TSD facilities and address the cause of non-compliance. The Task Force comprises personnel from an EPA Headquarters core team, Regional Offices, and the States.

The prinicipal objective of the inspection at Hughes Aircraft was to determine compliance with the requirements of 40 CFR Part 265, Subpart F - Ground Water Monitoring. Compliance with related requirements of the Part 265 interim status regulations, Hazardous and Solid Waste Amendments of RCRA, and the corresponding State regulations was also investigated. Additionally, the ground water monitoring program proposed for final Part B permitting status was evaluated for compliance with Part 270.14(c).

and/or the

Recent amendments to RCRA require that facilities seeking a RCRA permit must also address solid waste management units at the facilities; therefore, ground water monitoring systems associated with any solid waste management units at the facility were also evaluated.

→ Based on the results of these investigations, a number of
i.e.
response actions were identified to attain compliance. ←

Specific objectives were as follows:

- To determine if the facility is in compliance with interim status ground water monitoring requirements of 40 CFR Part 265 as promulgated under RCRA and the State equivalent (as the State of Arizona has received RCRA authorization).
- To determine if the ground water monitoring program described in the facility's RCRA Part B permit application complies with 40 CFR Part 270.14(c).
- To determine if the ground water at the facility contains hazardous waste constituents.
- To determine if the ground water monitoring system can immediately detect any statistically significant amounts of hazardous waste constituents that migrate from the waste management area to the uppermost aquifer underlying the facility.
- To determine if Hughes has developed and is following an adequate plan and procedures for ground water sampling and analysis.
- To determine if the ground water quality assessment program outline (or plan, as appropriate) is adequate.
- To determine if recordkeeping and reporting procedures for ground water monitoring are adequate.
- To identify active and inactive solid waste management units.

To accomplish these objectives, the investigation consisted of several discrete components including a ground water sampling program, a sampling audit, and a complete record review. Frances Schultz, Donn Zuroski, and Mark Filippini of EPA Region 9 comprised the investigation team. The team included Steve Callaway from Arizona Department of Health Services, Bob Henckel with the Arizona Department of Water Resources, Dan Opalski with EPA Region 9 Superfund, and other State and EPA personnel.

Sampling of six facility wells, direction of the four person Versar Inc. contract sampling team, and the audit of the facility sampling procedures was conducted by Frances Schultz of the Field Operations Branch, EPA Region 9.

1.b

PB89-125405

April 88

EPA-700-8-87-037

Hazardous Waste Ground-Water Task Force

Evaluation of Hughes Aircraft, U.S. Air Force Plant No. 44 Tucson, Arizona

EPA

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
SPRINGFIELD, VA. 22161

United States Environmental Protection Agency

NOTICE

THIS DOCUMENT HAS BEEN REPRODUCED FROM THE BEST COPY FURNISHED US BY THE SPONSORING AGENCY. ALTHOUGH IT IS RECOGNIZED THAT CERTAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RELEASED IN THE INTEREST OF MAKING AVAILABLE AS MUCH INFORMATION AS POSSIBLE.

1-d

EPA-700-8-87-037

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
HAZARDOUS WASTE GROUND WATER TASK FORCE

GROUND WATER MONITORING EVALUATION
HUGHES AIRCRAFT, U.S. AIR FORCE PLANT NO. 44
TUCSON, ARIZONA

April 1988

Mark G. Filippini
Donn Zuroski
U.S. Environmental Protection Agency
Region 9

April 29, 1988

UPDATE OF THE HAZARDOUS WASTE GROUND WATER TASK FORCE EVALUATION OF HUGHES AIRCRAFT/U.S. AIR FORCE PLANT No. 44, TUCSON, ARIZONA

The United States Environmental Protection Agency's Hazardous Waste Ground Water Task Force (Task Force) in conjunction with the State of Arizona Department of Health Services (now the Department of Environmental Quality) and the Arizona Department of Water Resources conducted an evaluation of the ground water monitoring program at Hughes Aircraft/U.S. Air Force Plant No. 44 (Hughes/AFP #44) located in Tucson, Arizona. Onsite field inspections were conducted between April 20 and 24, 1987. The evaluation of the facility focused on (1) determining if the facility was in compliance with applicable regulatory ground water requirements and policies under the Resource Conservation and Recovery Act (RCRA), (2) determining the nature of hazardous waste constituents present in the ground water, and (3) identifying inactive solid waste management units.

Hughes/AFP #44 is one of 58 facilities that are to be evaluated by the Task Force. The Task Force effort came about in response to concerns by Congress and the public as to whether hazardous waste treatment, storage, and disposal facilities are complying with the State and Federal ground water monitoring regulations.

The results of the chemical analysis of ground water samples collected from existing monitoring wells at the facility indicated the presence of several previously unidentified organic contaminants and elevated levels of radionuclide parameters in a RCRA perched zone well. Due to the deficiencies in the design of the ground water monitoring system, it cannot be determined if the compounds are the result of releases from the RCRA units or solid waste management units (SWMU's) at the facility. Additional work will be necessary to determine the nature, extent, and origin of these compounds.

In order to comply with ground water monitoring permit requirements, a facility's ground water monitoring system must be capable of immediately detecting a release of hazardous waste constituents from a regulated unit. Hughes/AFP #44 does not have in place a ground water monitoring system capable of meeting these requirements. Hughes/AFP #44 has been operating under a Federal Facility Compliance Agreement since May, 1984, which authorized use of an alternative ground water monitoring system. That agreement terminates on issuance of a RCRA operating permit.

In October 1987, EPA and the State of Arizona received from Hughes Aircraft a revised Part B permit application which includes a proposal to install a ground water monitoring system consistent with current technical guidance. Both agencies are reviewing the proposed system. It is anticipated that a determination on the issuing of an operating permit by the Agencies will be made by September 1988.

EPA conducted a RCRA Facility Assessment to determine the status of solid waste management units (SWMU's) at Hughes/AFP #44 in August of 1987. Over 100 solid waste management units (SWMU's) were documented at the Hughes/AFP #44 facility. Only limited investigations on selected units have been conducted by the facility, and most units have not been properly characterized. A thorough characterization of these units and any required corrective measures will be necessary to meet the requirements of the 1984 Hazardous and Solid Waste Amendments (HSWA) to RCRA.

Despite documented ground water contamination, the facility has claimed that no continuing sources of contamination exist at this site. Hughes/AFP #44 is currently operating a pump and treat system to remove contaminants from the ground water. In February, 1988, Hughes Aircraft notified EPA that they have sampled and analyzed soils at an on-site abandoned waste disposal unit and have determined that the soil is contaminated with TCE. The facility has implemented only limited source control measures to correct continuing releases.

Should it be determined by the Arizona Department of Environmental Quality and the Regional Administrator of EPA that the Part B application meets the RCRA Part 264 requirements for an operating permit, corrective action conditions will be written into the permit to address the SWMU's. These permit conditions will require the facility to identify, characterize, and take appropriate corrective action on all SWMU's at the facility as required under the HSWA portion of RCRA. Further, the permit would require upgrading of the ground water monitoring system.

If the agencies deny the operating permit, appropriate enforcement action, rather than permit conditions, could be taken to assure that releases from the SWMU's are addressed and that an adequate ground water monitoring system is installed.

In response to actions taken by Hughes Aircraft during the Task Force inspection EPA has initiated an in-depth investigation into possible violations of RCRA related to waste handling, waste disposal and record keeping procedures at Hughes/AFP #44.

Based on this Task Force investigation the facility must do the following:

1. Submit an adequate hydrogeologic site characterization report which includes identification of potential pathways for contaminant migration and a determination of the impact of the Installation Restoration Program (CERCLA) pump and treat system on the local hydrogeology.

2. Install a ground water monitoring system capable of meeting the requirements of RCRA §264 Subpart F.

3. Provide an updated Sampling and Analysis Plan that establishes the procedures to be used by the facility and identifies the laboratory that will analyze the samples.

4. Conduct a ground water assessment program to determine the source of the elevated radionuclides detected in the perched zone well.

5. Determine the existence, nature, content, and impact on the ground water of all SWMU's on the facility.

As stated above, it is anticipated that the technical aspects of the above items will be addressed through the permitting process. Enforcement action may be pursued if necessary.

This concludes the Hazardous Waste Ground Water Task Force evaluation of the Hughes Aircraft/U.S. Air Force Plant #44 facility.

Donn Zuroski
U.S. Environmental Protection Agency

CONTENTS

page

I. EXECUTIVE SUMMARY 1

A. INTRODUCTION 1

1 Task Force Objectives 1
2 Background 3

B. SUMMARY OF FINDINGS AND CONCLUSIONS 8

1 Ground Water Monitoring System 8
2 Task Force Sampling Data 9
3 Conclusions 10

II. TECHNICAL REPORT 12

A. BACKGROUND 12

1 Site History 12
2 Enforcement History 12
a. CERCLA Enforcement 13
b. RCRA Ground Water Enforcement 15

B. INVESTIGATIVE METHODS 16

1 Facility Inspection/Records Review 16
2 Sampling Audit 17
3 Sampling Program 18

C. WASTE MANAGEMENT UNITS AND OPERATIONS 20

1 Current RCRA Units 20
2 Solid Waste Management Units 21

D. SITE GEOLOGY/HYDROGEOLOGY 23

1 Geomorphology 23
2 Geology 24
3 Soils 29
4 Hydrogeology 29
5 Climate 30

E. INTERIM STATUS GROUND WATER MONITORING 31

1 Current Monitoring System 31
2 Sampling & Analysis Plan and Field Procedures 36

(continued)

II. (Continued)

page

F. TASK FORCE DATA COLLECTION/RESULTS 38

1 Sample Collection Methods 38
2 Results of Task Force Data 42

REFERENCES 46

APPENDICIES

APPENDIX A Analytical Parameters

APPENDIX B Review of Neutron Probe System at Hughes Aircraft
Report from Environmental Monitoring Systems
Laboratory - Las Vegas

I. EXECUTIVE SUMMARY

A. INTRODUCTION

1. Task Force Objectives

This report summarizes the results of investigations conducted during April 1987 at the Hughes Aircraft/Air Force Plant #44 in Tucson, Arizona by the U.S. Environmental Protection Agency.

Operations at hazardous waste treatment, storage, and disposal (TSD) facilities are regulated by the Resource Conservation and Recovery Act. Regulations promulgated pursuant to RCRA (40 CFR Parts 260 through 265, effective on November 19, 1980 and subsequently modified) address hazardous waste site operations including monitoring of ground water to ensure that hazardous waste constituents could be immediately detected if released to the environment. The regulations for TSD facilities are implemented (for EPA administered programs) through the hazardous waste permit program outlined in 40 CFR Part 270.

The Adminstrator of the Environmental Protection Agency (EPA) established a Hazardous Waste Ground Water Task Force (Task Force) to evaluate the level of compliance with ground water monitoring requirements at commercial off-site and selected on-site TSD facilities and address the cause of non-compliance. The Task Force comprises personnel from an EPA Headquarters core team, Regional Offices, and the States.

The prinicipal objective of the inspection at Hughes Aircraft was to determine compliance with the requirements of 40 CFR Part 265, Subpart F - Ground Water Monitoring. Compliance with related requirements of the Part 265 interim status regulations, Hazardous and Solid Waste Amendments of RCRA, and the corresponding State regulations was also investigated. Additionally, the ground water monitoring program proposed for final Part B permitting status was evaluated for compliance with Part 270.14(c).

Recent amendments to RCRA require that facilities seeking a RCRA permit must also address solid waste management units at the facilities; therefore, ground water monitoring systems associated with any solid waste management units at the facility were also evaluated.

Specific objectives were as follows:

- To determine if the facility is in compliance with interim status ground water monitoring requirements of 40 CFR Part 265 as promulgated under RCRA and the State equivalent (as the State of Arizona has received RCRA authorization).
- To determine if the ground water monitoring program described in the facility's RCRA Part B permit application complies with 40 CFR Part 270.14(c).
- To determine if the ground water at the facility contains hazardous waste constituents.
- To determine if the ground water monitoring system can immediately detect any statistically significant amounts of hazardous waste constituents that migrate from the waste management area to the uppermost aquifer underlying the facility.
- To determine if Hughes has developed and is following an adequate plan and procedures for ground water sampling and analysis.
- To determine if the ground water quality assessment program outline (or plan, as appropriate) is adequate.
- To determine if recordkeeping and reporting procedures for ground water monitoring are adequate.
- To identify active and inactive solid waste management units.

To accomplish these objectives, the investigation consisted of several discrete components including a ground water sampling program, a sampling audit, and a complete record review. Frances Schultz, Donn Zuroski, and Mark Filippini of EPA Region 9 comprised the investigation team. The team included Steve Callaway from Arizona Department of Health Services, Bob Henckel with the Arizona Department of Water Resources, Dan Opalski with EPA Region 9 Superfund, and other State and EPA personnel.

Sampling of six facility wells, direction of the four person Versar Inc. contract sampling team, and the audit of the facility sampling procedures was conducted by Frances Schultz of the Field Operations Branch, EPA Region 9.

2. Background

Hughes Aircraft Company has operated U.S. Air Force Plant No. 44 under contract as a government-owned, contractor-operated (GOCO) military facility since 1951. The Plant is located on Air Force property in Tucson, Arizona, immediately adjacent to the Tucson International Airport (Figure 1 & 2).

The plant site encompasses 2,257 acres and includes 67 structures. Hughes employs 6,000 people at this plant, which manufactures tactical missile systems. The RCRA regulated units at the facility are part of an industrial wastewater treatment plant (IWWTP) which is designed to recycle 75% of its industrial wastewater back into the industrial water supply. The IWWTP, constructed in 1977, is located at the southwest corner of the plant site and includes 15 holding ponds, 20 evaporation beds, and two tank treatment systems covering approximately 33 acres (Figure 3). These units receive three listed hazardous wastes: F007, spent cyanide plating bath solutions from electroplating operations; F008, plating bath sludges from electroplating operations; and F009, spent stripping and cleaning bath solutions from electroplating operations, plus two characteristic waste streams containing chromium (D007) and lead (D008).

Ground water contamination at the Tucson International Airport area was discovered in the early 1950's. Intensive investigations of the ground water did not occur until 1979 when Hughes initiated a ground water quality sampling program prompted by EPA.

Several areas of contamination have been identified in the area (Figure 4). Ground water samples were found to contain heavy metals, trichloroethylene (TCE), dichloroethylene (DCE), and trichloroethane (TCA).

Most of the monitoring and clean-up activities occuring at the facility are being directed by the Air Force under the Installation Restoration Program, the Department of Defense's CERCLA process. A ground water extraction treatment and reinjection system, which includes air stripping and ion exchange to remove contaminants, went on line in April 1987.

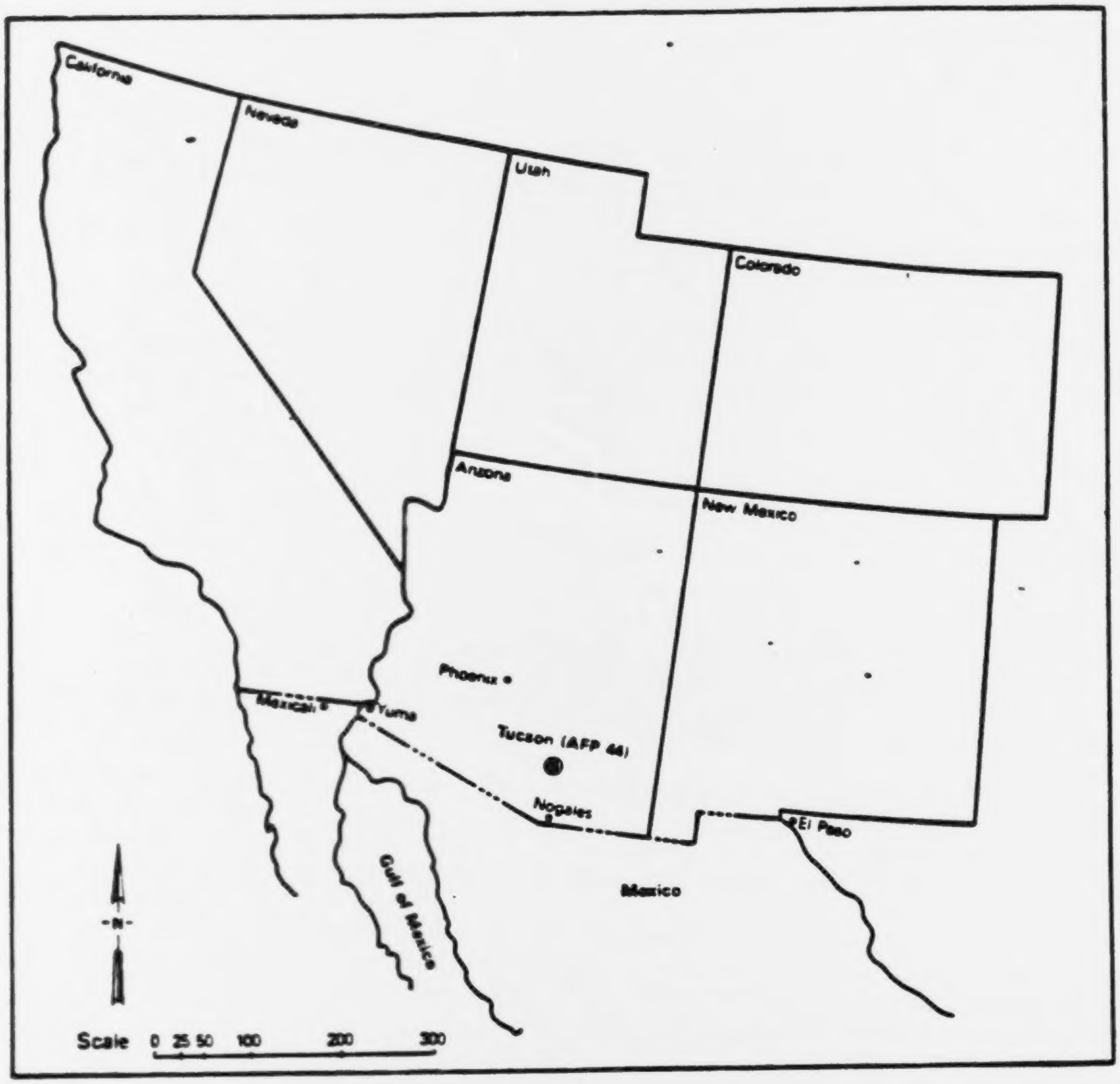

California
Nevada
Utah
Colorado
Arizona
New Mexico
Phoenix
Tucson (AFP 44)
Mexicali
Yuma
Nogales
El Paso
Mexico
Gulf of Mexico
N
Scale 0 25 50 100 200 300

Figure 1. Regional Location of AFP 44, Tucson, Arizona

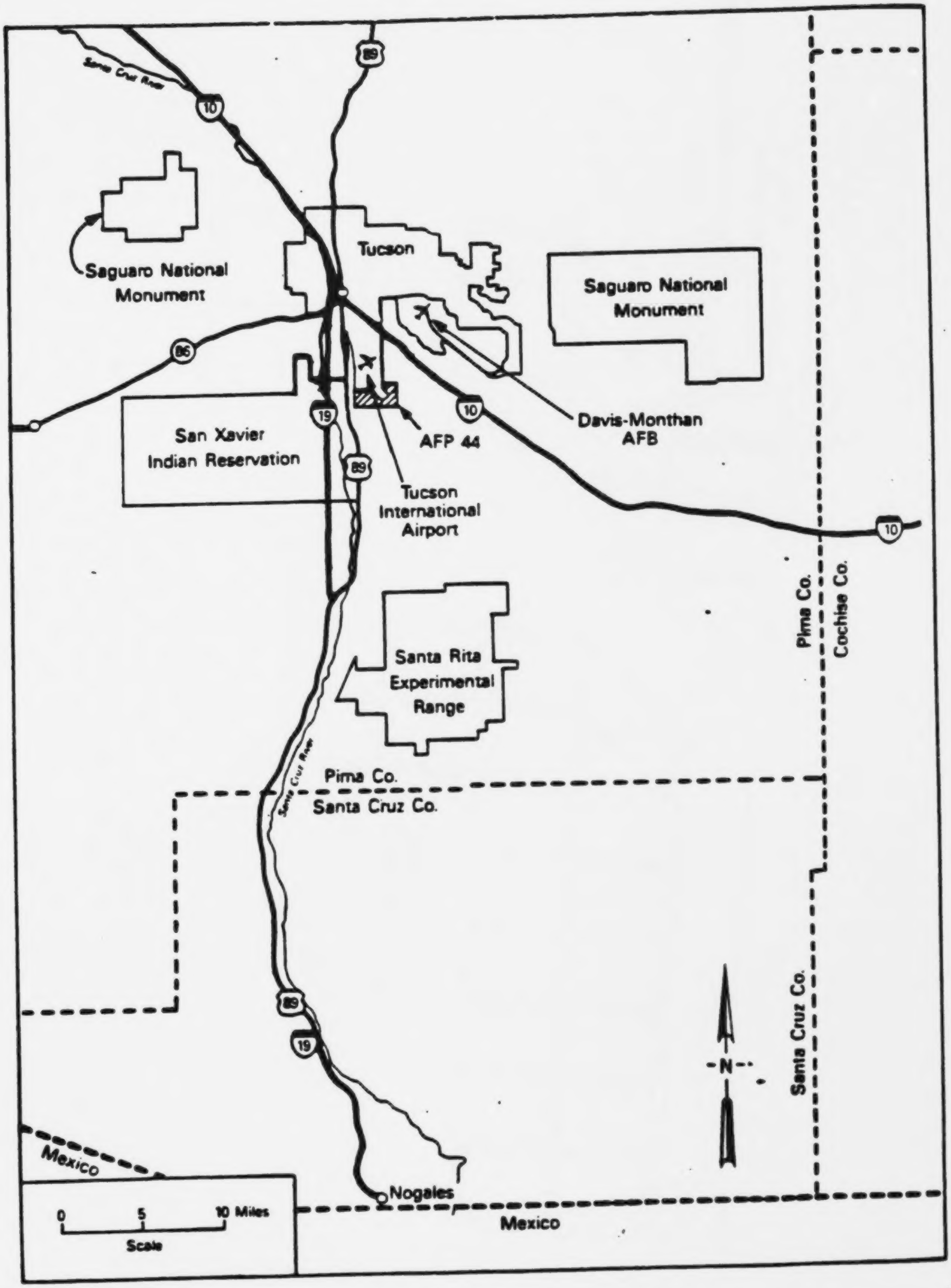

Santa Cruz River
10
89
Saguaro National Monument
Tucson
Saguaro National Monument
86
Davis-Monthan AFB
AFP 44
10
19
San Xavier Indian Reservation
89
Tucson International Airport
10
Pima Co.
Cochise Co.
Santa Rita Experimental Range
Santa Cruz River
Pima Co.
Santa Cruz Co.
89
19
N
Santa Cruz Co.
Mexico
Nogales
Mexico
0
5
10 Miles
Scale

Figure 2. Location of AFP 44 in Tucson Area, Arizona

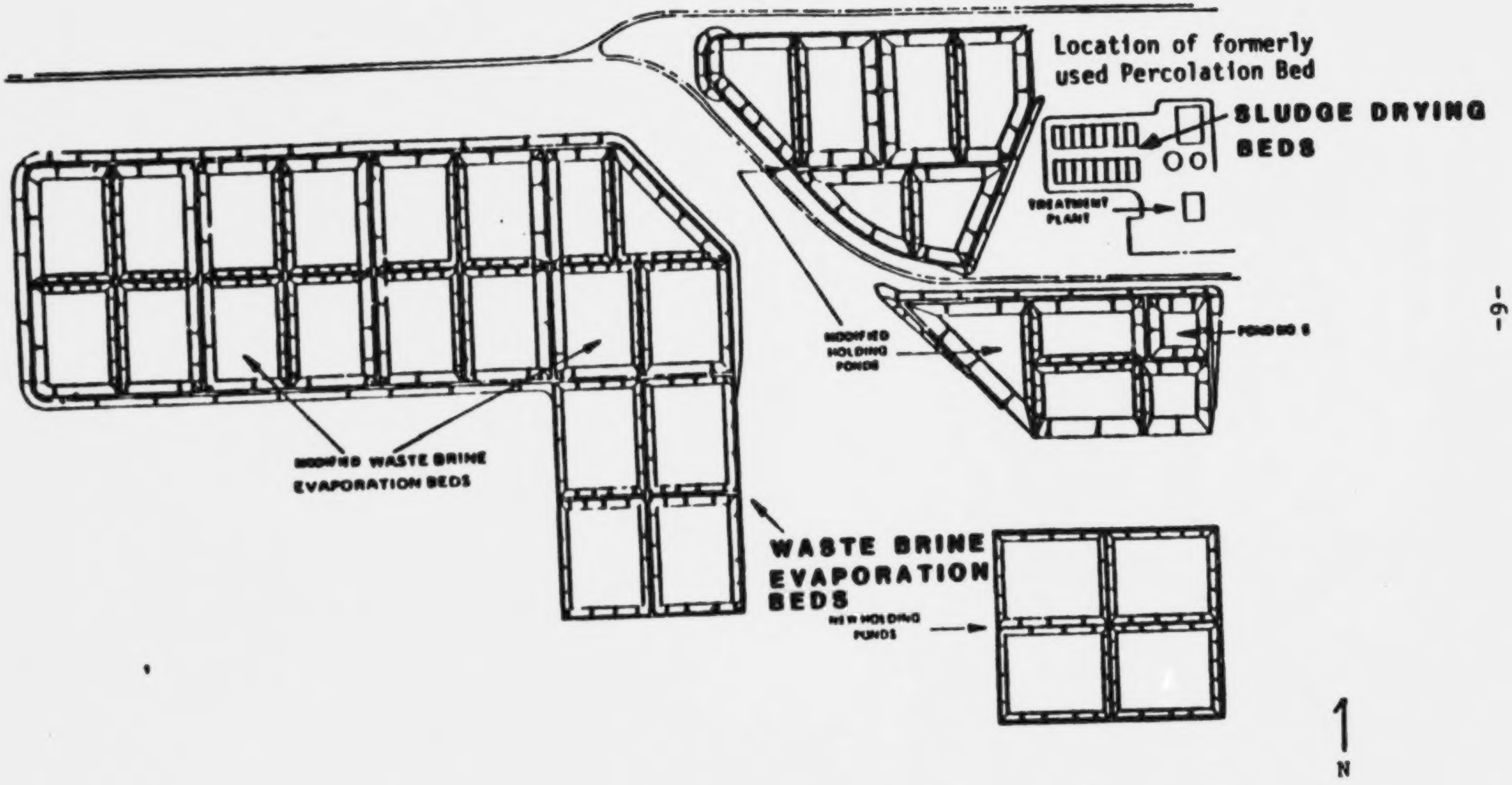

Location of formerly used Percolation Bed
SLUDGE DRYING BEDS
TREATMENT PLANT
MODIFIED HOLDING PONDS
POND NO 5
MODIFIED WASTE BRINE EVAPORATION BEDS
WASTE BRINE EVAPORATION BEDS
NEW HOLDING PONDS
N

FIGURE 3 IWWTP PONDS AND BEDS (see Figure 4)

Reproduced from best available copy.

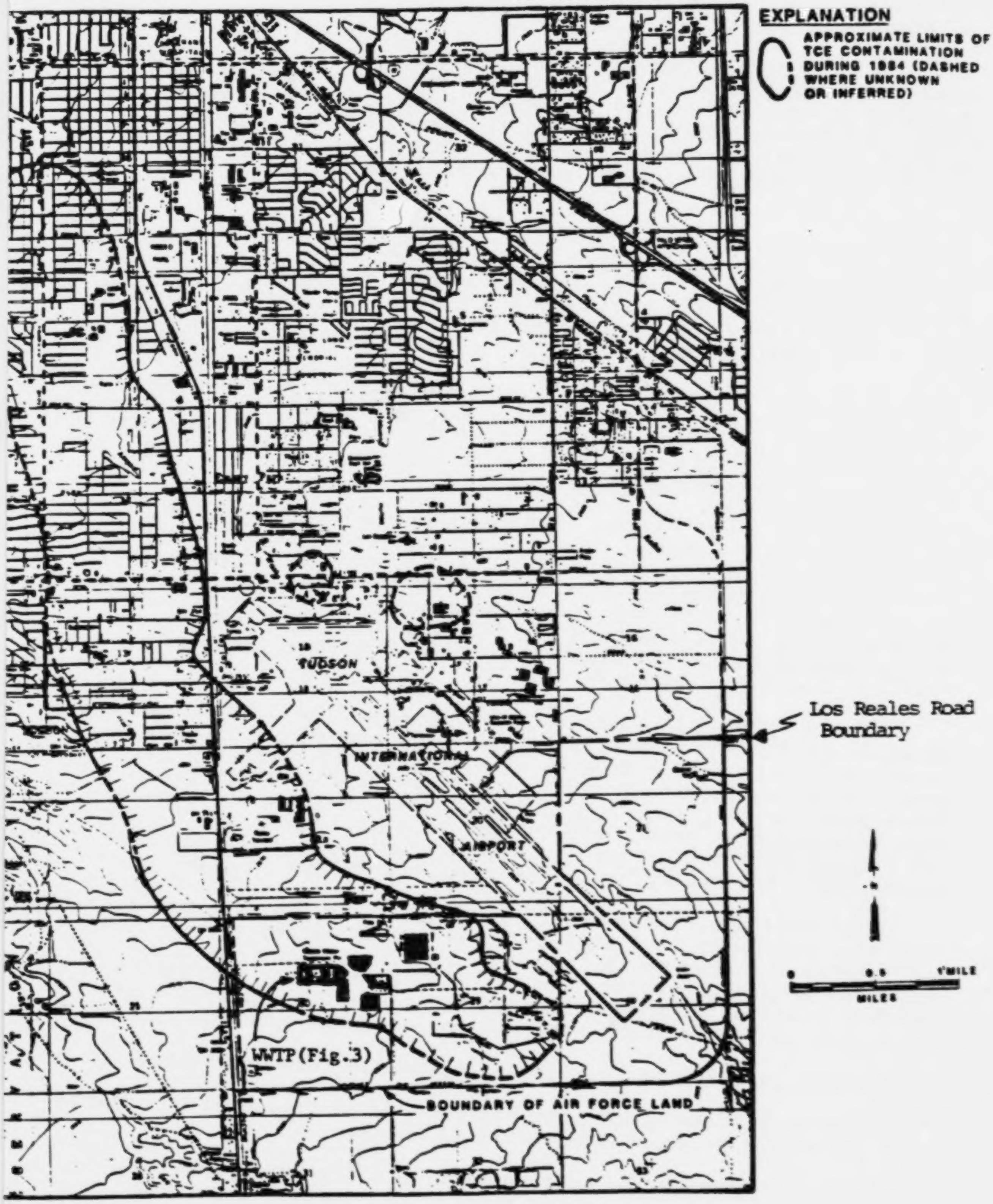

EXPLANATION
APPROXIMATE LIMITS OF TCE CONTAMINATION DURING 1984 (DASHED WHERE UNKNOWN OR INFERRED)
TUCSON
INTERNATIONAL
AIRPORT
Los Reales Road Boundary
WWTP(Fig.3)
BOUNDARY OF AIR FORCE LAND
N
0
0.5
1 MILE
MILES

Figure 4
LOCATION OF TUCSON AIRPORT AREA
TUCSON AIRPORT AREA

B. SUMMARY OF FINDINGS AND CONCLUSIONS

The findings and conclusions presented in this report reflect conditions existing at the facility and practices used by the facility at the time of the Task Force investigation in April 1987. Subsequent actions taken by the facility, the State of Arizona, and EPA Region 9 since the investigation are summarized in the accompanying update cover memo attached to this report.

1. Ground Water Monitoring System

The Task Force investigated the interim status ground water monitoring program implemented by Hughes Aircraft/Air Force Plant #44. The consensus opinion of the Task Force is that, although the facility was in compliance with the 1984 Federal Facility Compliance Agreement (FFCA) entered into between EPA and the Air Force, the ground water monitoring program is not in compliance with 40 CFR Part 265 Subpart F or 40 CFR Part 270.14 (c). The FFCA allowed the current monitoring system, consisting of perched zone wells and neutron probes, in lieu of a system meeting the 265 Subpart F requirements.

According to 265.90, an owner/operator of a land disposal facility must implement a ground water monitoring system capable of determining the facility's impact on the quality of the ground water in the uppermost aquifer underlying the facility. This program was to be implemented by November 1981. At the time of the Task Force investigation, the facility had not implemented such a program but was operating in accordance with the Federal Facility Compliance Agreement.

According to 270.14 (c), an owner/operator must submit an application for a Part B RCRA Permit which proposed a ground water monitoring system capable of meeting 264 Subpart F. The ground water monitoring system proposed by Hughes in its last three RCRA Part B Permit applications, the latest at the time of this investigation being January 1987, failed to meet any of the 270 requirements but instead proposed to continue the alternate ground water monitoring system imposed by the FFCA in 1984.

The FFCA monitoring system is based on the belief that any leak from the ponds will migrate horizontally in the vadose zone and then be detected by the neutron probe system, or that the leak will affect the water level in the perched zone and will be noted in sampling of the perched zone wells. The capability of the system to detect leaks has not been adequately demonstrated.

The present ground water monitoring system is inadequate because:

1) The neutron probe system has not been demonstrated to be capable of detecting releases from the RCRA units.

2) The present monitoring wells placed in the perched zone do not monitor the uppermost aquifer immediately under the RCRA units per 265.91 (a).

3) There are no designated upgradient wells as required in 265.91 (a)(1).

4) Most of the wells monitored under the FFCA are dry wells. Analysis is performed only when the ground water is high enough so that the wells can be sampled.

5) Wells are not constructed properly as required per 265.91(c) or RCRA guidance.

6) Facility never conducted analysis of Appendix III parameters (EPA Interim Primary Drinking Water Standards) as is required per 265.92(c).

7) Ground water sample analysis is inadequate for RCRA 265 monitoring purposes because there is no annual analysis for phenols, total organic carbon, or total organic halogens as required per 265.93(d).

8) The facility's sampling and analysis plan is incomplete.

9) Sampling personnel did not follow all procedures described in the sampling and analysis plan in the field.

10) Facility does not have an outline for a ground water quality assessment program as required per 265.93(a).

11) Facility has not conducted any statistical analysis of ground water monitoring data as is required per 265.93(b).

12) Facility has not determined the influence of the CERCLA pump and treat system on the local ground water flow.

13) Facility has failed to submit a proposed ground water monitoring program per 270.14(c)(1) through (8).

2. Task Force Sampling Data

As part of the Task Force investigation, samples were collected from six facility wells. Only one of the six wells sampled was part of the the RCRA monitoring program. The purpose of sampling non-RCRA wells was to confirm reported levels of contaminants and sample for expanded parameters. The sampling was not meant to establish any releases from the regulated units. Well placement and construction, as well as the existence of solid waste management units in the area, precluded the Task Force from being able to make meaningful determinations of releases from the data. Samples were analyzed for Appendix IX and RCRA indicator parameters (Appendix A).

Results of the Task Force data are provided in Section II F 2. The Task Force data on the six sampling points confirmed the identification of a total of five different organic compounds in the Hughes wells. In addition, two unknown hydrocarbons and elevated radionuclides were detected in RCRA monitoring well S-10.

As expected based on Superfund investigations, trichloroethene (TCE) and 1,1-dichloroethene (DCE) were found in most wells. TCE was found in all wells except M-15. Levels ranged from 79 to 1800 ppb. DCE was found in wells S-10, M-2B and M-41 at levels ranging from 22 to 230 ppb. Trans-1,2-dichloroethene was also detected in well M-41.

Well S-10 was found to be the most heavily contaminated well, where, in addition to TCE and DCE, Caprolactam (20 ppb), 1-Hexanol 2-Ethyl (9 ppb) and two unknown hydrocarbons were detected. Levels of metals and many indicator parameters were also higher in S-10 than in surrounding regional aquifer wells. Radionuclide levels in well S-10 were dramatically higher than in all other wells sampled. Total radium was reported at 33±4 pCi/l, gross alpha was reported at 180±90 pCi/l, and gross beta was reported at 350±90 pCi/l. These levels of radionuclides were two orders of magnitude higher than in surrounding wells. It could not be determined if these levels are naturally occuring or indicate some unknown source. Levels of barium, chromium, and nitrate nitrogen were also elevated in well S-10. Dissolved barium was reported at 219 ppb, dissolved chromium was reported at 281 ppb, and nitrate nitrogen was reported at 11,000 ppb.

These results indicate some unknown source or sources of contamination exist in the area, either solid waste management units or RCRA units. Limitations of the Task Force data and the inadequacy of the monitoring system make it impossible to confirm the existence and nature of these sources. This demonstrates the limited capabilities of the neutron probe system, the perched zone wells and the analytical parameters selected.

3. Conclusions

In summary, we have found the following at the facility as a result of this investigation:

- The facility does not have in place a ground water monitoring system capable of meeting RCRA 40 CFR Parts 265 or 264 ground water monitoring requirements.
- The facility has not submitted a hydrogeologic site characterization report as required under § 270.14(c).
- Several facility wells sampled by the Task Force have shown previously unreported levels of some organic and inorganic constituents indicating the possibility of some unknown sources of contamination not yet identified by the facility.
- The designated RCRA monitoring wells are not properly designed or constructed.
- Hughes' groundwater sampling and analysis plan is incomplete.

- The facility did not follow all procedures described in the sampling and analysis plan.
- Proper reporting procedures for ground water monitoring data and recordkeeping procedures in the field are not being followed.
- The facility does not have a ground water quality assessment outline.
- A determination of the influence of the Installation Restoration Program (CERCLA) pump and treat system on the local ground water flows has not been conducted.
- A thorough analysis of location and content of the solid waste management units at the facility and their potential impact on the ground water has not been conducted.
- Although a ground water restoration program is in place at the facility, only limited source control investigations or measures have been conducted at the facility.
- Despite the documented existence of over 100 solid waste management units at the facility, facility-generated reports claim that no continuous sources of ground water contamination exist.

II. TECHNICAL REPORT

A. BACKGROUND

1. Site History

Hughes Aircraft operates U.S. Air Force Plant 44 (AFP 44). The plant has been active since 1951. Hughes/AFP #44 is a government-owned, contractor-operated (GOCO) operation. The facility has a workforce of 6000 people employed manufacturing tactical missile systems. The installation encompasses 2,258 acres of desert land. Over 80 percent of the installation property is undeveloped.

Industrial wastewaters generated by processing operations have been treated on-site since production began in 1952. Treatment methods have evolved from batch and flow-thru treatment to the present day zero-discharge system.

From 1952 until 1961, processing solutions of sulphuric, hydrofluoric, nitric, hydrochloric, acetic, and phosphoric acids were diluted in tanks and discharged into a natural drainage wash. Records indicate that approximately 20,000 gallons per week were disposed of in this manner.

In 1954 a batch treatment plant came on line. The plant treated concentrated solutions of chrome and concentrated solutions of cyanide wastewaters. The cyanide solutions were oxidized, the chromic solutions were reduced from hexavalent to trivalent chromium. The treated solutions were then mixed with cooling water blowdown and discharged through the natural drainage wash into unlined ponds. Facility records indicate that approximately 160 gallons per week were disposed of in this manner.

In 1962 a flow-through treatment system was added to the batch treatment facility. This system handled rinsewaters other than solutions of chrome and cyanide. The system generated a heavy metal sludge which was sent to unlined drying beds. The treated wastewaters were discharged through the natural drainage wash into unlined ponds. Records indicate that between 1962 and 1977 approximately 15,000 gallons of chrome and cyanide wastewaters per week and 1,250,000 gallons of rinsewaters per week were discharged to the natural drainage wash.

Between 1952 and 1977 general industrial wastes and industrial wastewaters were disposed of on site in ponds, pits and drainage channels. Waste types included machining coolants and lubricants, TCA, TCE, methylene chloride, paint sludges and thinners, plating and deburring rinsewater, acid solutions, caustics, cyanide solutions, heavy metal sludge, alcohols, and flammable solvents including acetone and MEK.

In 1977 a zero discharge wastewater treatment plant come on line. The new treatment plant employed batch treatment of cyanide and acid wastes as well as a flow-through system to treat general industrial wastes. In 1984 the wastewater treatment plant ponds were retrofitted with double liners with a leak detection system.

Over 100 solid waste management units (SWMU's) have been identified at the facility. They include unlined pits, unlined wastewater ponds, sludge drying beds, drainage channels, explosive pits, and numerous tanks. Historic and present waste management practices are detailed in the RCRA Facility Assessment report discussed later and included in the EPA Hughes file.

The facility is now pursuing a RCRA Part B permit for the wastewater treatment plant surface impoundments. The facility has proposed as part of their permit the ground water monitoring system agreed to in the 1984 Federal Facility Compliance Agreement consisting of the neutron probe and the perched zone wells.

2. Enforcement History

a. CERCLA Enforcement

Ground water contamination in the Tucson International Airport area was discovered in the early 1950's. Intensive investigation of ground water contamination did not occur until 1979 when Hughes initiated a ground water quality sampling program prompted by the EPA.

In March 1981 an investigation conducted by EPA (under CERCLA) identified trichloroethylene (TCE) and chromium contamination in the ground water around the Tucson International Airport. As a result, seven municipal wells were removed from service. Subsequent investigations have resulted in the delineation of three distinct areas of contamination. The largest encompasses about five square miles of aquifer surface area. Most of the contamination is believed to be within the uppermost 100 feet of the saturated zone, although a thorough site characterization report has not been submitted.

In November 1982, Hughes and the U.S. Air Force assumed responsibility for investigating contamination south of Los Reales Road, while EPA assumed responsibility for investigating contamination north of Los Reales Road (see Figure 4). Ground water samples at Hughes were found to contain trichloroethylene (TCE), dichloroethylene (DCE), trichloroethane (TCA), hexavalent chrome, benzene, xylene, and chloroform. Hughes and the Air Force have concluded that contamination beneath the facility had been caused by past disposal of waste solvents and chromium and claimed that no continuing sources existed on the facility (Hargis and Montgomery, Phase I, 1982). Consequently, the Installation

Restoration Program (IRP) conducted by the Air Force in 1985 did not contain any proposed source control measures despite the existence of over 100 SWMU's at the facility. This study concluded that the contamination had moved off-site.

The Tucson Airport Area Remedial Investigation (RI) was concluded in 1985 and covered that portion of the known contamination north of Los Reales Road (i.e. that portion not covered by the Air Force IRP). The RI was managed by ADHS under a cooperative agreement with EPA Region 9. Major components of the RI included drilling, testing and sampling of ground water, development of a solute transport model, studies of potential sources of ground water pollution, and interpretation of hydrogeologic and water chemistry quality data.

Studies of the Tucson International Airport Area have classified three aquifers in the area of contamination; the upper, the lower, and the undivided aquifer. The undivided aquifer has been defined by Hargis & Montgomery (Phase II, 1982) as that portion of the regional aquifer which does not contain a perched zone. Hargis and Montgomery have stated that the undivided portion of the aquifer does not exist beneath the facility (i.e. the perched zone extends beneath the entire portion of the wastewater treatment plant RCRA units).

To date, over 100 monitoring wells have been drilled to identify, characterize, model, and monitor the contamination in the area. These wells have shown that: the perched zone has been contaminated with chromium, toluene, TCE, TCA, and DCE; the upper aquifer zone has been contaminated with chromium, TCE, TCA, and DCE; the lower aquifer zone has been contaminated (to a lesser degree) with chromium TCE, TCA and DCE.

Eighteen remedial alternatives were designed and analyzed by consultants to the Air Force as part of the Remedial Action Plan (RAP) for Hughes. The Air Force selected ground water extraction, treatment, and recharge as the preferred remedy. The remedial system includes a network of ground water extraction wells, a treatment plant, and a network of wells to inject the treated ground water. This project involves pumping, treating, and recharging approximately 26 billion gallons of water. The treatment plant will be in full operation by 1988. The Air Force estimates that at least 10 years will be required to remove the volatile organic compounds and chromium. Extraction and injection wells surround the RCRA surface impoundments at the facility.

In 1977 a zero discharge wastewater treatment plant come on line. The new treatment plant employed batch treatment of cyanide and acid wastes as well as a flow-through system to treat general industrial wastes. In 1984 the wastewater treatment plant ponds were retrofitted with double liners with a leak detection system.

Over 100 solid waste management units (SWMU's) have been identified at the facility. They include unlined pits, unlined wastewater ponds, sludge drying beds, drainage channels, explosive pits, and numerous tanks. Historic and present waste management practices are detailed in the RCRA Facility Assessment report discussed later and included in the EPA Hughes file.

The facility is now pursuing a RCRA Part B permit for the wastewater treatment plant surface impoundments. The facility has proposed as part of their permit the ground water monitoring system agreed to in the 1984 Federal Facility Compliance Agreement consisting of the neutron probe and the perched zone wells.

2. Enforcement History

a. CERCLA Enforcement

Ground water contamination in the Tucson International Airport area was discovered in the early 1950's. Intensive investigation of ground water contamination did not occur until 1979 when Hughes initiated a ground water quality sampling program prompted by the EPA.

In March 1981 an investigation conducted by EPA (under CERCLA) identified trichloroethylene (TCE) and chromium contamination in the ground water around the Tucson International Airport. As a result, seven municipal wells were removed from service. Subsequent investigations have resulted in the delineation of three distinct areas of contamination. The largest encompasses about five square miles of aquifer surface area. Most of the contamination is believed to be within the uppermost 100 feet of the saturated zone, although a thorough site characterization report has not been submitted.

In November 1982, Hughes and the U.S. Air Force assumed responsibility for investigating contamination south of Los Reales Road, while EPA assumed responsibility for investigating contamination north of Los Reales Road (see Figure 4). Ground water samples at Hughes were found to contain trichloroethylene (TCE), dichloroethylene (DCE), trichloroethane (TCA), hexavalent chrome, benzene, xylene, and chloroform. Hughes and the Air Force have concluded that contamination beneath the facility had been caused by past disposal of waste solvents and chromium and claimed that no continuing sources existed on the facility (Hargis and Montgomery, Phase I, 1982). Consequently, the Installation

Restoration Program (IRP) conducted by the Air Force in 1985 did not contain any proposed source control measures despite the existence of over 100 SWMU's at the facility. This study concluded that the contamination had moved off-site.

The Tucson Airport Area Remedial Investigation (RI) was concluded in 1985 and covered that portion of the known contamination north of Los Reales Road (i.e. that portion not covered by the Air Force IRP). The RI was managed by ADHS under a cooperative agreement with EPA Region 9. Major components of the RI included drilling, testing and sampling of ground water, development of a solute transport model, studies of potential sources of ground water pollution, and interpretation of hydrogeologic and water chemistry quality data.

Studies of the Tucson International Airport Area have classified three aquifers in the area of contamination; the upper, the lower, and the undivided aquifer. The undivided aquifer has been defined by Hargis & Montgomery (Phase II, 1982) as that portion of the regional aquifer which does not contain a perched zone. Hargis and Montgomery have stated that the undivided portion of the aquifer does not exist beneath the facility (i.e. the perched zone extends beneath the entire portion of the wastewater treatment plant RCRA units).

To date, over 100 monitoring wells have been drilled to identify, characterize, model, and monitor the contamination in the area. These wells have shown that: the perched zone has been contaminated with chromium, toluene, TCE, TCA, and DCE; the upper aquifer zone has been contaminated with chromium, TCE, TCA, and DCE; the lower aquifer zone has been contaminated (to a lesser degree) with chromium TCE, TCA and DCE.

Eighteen remedial alternatives were designed and analyzed by consultants to the Air Force as part of the Remedial Action Plan (RAP) for Hughes. The Air Force selected ground water extraction, treatment, and recharge as the preferred remedy. The remedial system includes a network of ground water extraction wells, a treatment plant, and a network of wells to inject the treated ground water. This project involves pumping, treating, and recharging approximately 26 billion gallons of water. The treatment plant will be in full operation by 1988. The Air Force estimates that at least 10 years will be required to remove the volatile organic compounds and chromium. Extraction and injection wells surround the RCRA surface impoundments at the facility.

b. RCRA Ground Water Enforcement

RCRA ground water monitoring at Hughes/AFP #44 is currently regulated by the state of Arizona under regulations equivalent to 40 CFR Part 265, Subpart F. The following is a summary, in chronological order, of major permiting and enforcement milestones.

- In November of 1980, the facility notified EPA as a RCRA TSD. The Part B application requested a ground water monitoring waiver. The waiver request was based on a leak detection system which uses a neutron probe monitoring network and leachate collection tubes under the ponds.
- An Interim Status inspection in September 1982 showed that sludge beds listed as being lined on the Part A notification were, in fact, unlined.
- A 1983 EPA report stated that an alternative to ground water monitoring could include neutron probes, but that the neutron probe system had been improperly installed.
- In April 1983, the facility notified ADHS that double liners would be installed at the sludge beds.
- EPA issued a compliance order in June of 1983 for failure to install a ground water monitoring system.
- A Federal Facilities Compliance Agreement (FFCA), signed in May 1984, waived 40 CFR 265 Subpart F ground water monitoring requirements and allowed the facility to use an upgraded neutron probe system used in conjunction with a water balance and perched zone monitoring system.
- May 1984, EPA found the proposal to double line the IWTP surface impoundments to be in compliance with current regulations.
- July 1984, EPA issued a Notice of Deficiency (NOD) stating that the August 1983 Part B submittal was incapable of meeting 264 Subpart F.
- December 1984, a revised Part B which incorporated the ground water monitoring system outlined in the FFCA was received.
- In January 1987, the facility submited an additional Part B revision as a result of process changes at the facility (not as a result of an NOD); the ground water portion is identical to December 1984 version.
- In May 1987, the Task Force conducted an investigation at the facility. In addition to sampling ground water monitoring wells, several pre-RCRA solid waste management units were inspected.
- In August 1987, EPA conducted a RCRA Facility Assessment (RFA) under the HWSA provisions. The RFA report was released in September 1987.

B. INVESTIGATIVE METHODS

Data gathering methods used for this investigation involved four major areas: record reviews and facility personnel interviews, ground water sampling and analysis, audit of sampling procedures, and investigations and inspections of on-site facility operations and disposal areas. Record reviews, facility personnel interviews, and on-site investigations were conducted by the project leaders Mark Filippini and Donn Zuroski, EPA Region 9. Both the ground water sampling and the sampling audit projects were led by Frances Schultz of Region 9 Field Inspections Section. A Project Plan was developed for the investigation by the project leaders and includes a Sampling Plan developed by the Field Team Leader. Laboratory audits, normally conducted during Task Force investigations, were not done due to resource limitations. However, the analytical laboratory used by the facility, Brown and Caldwell of Pasadena, California, was audited in a previous Task Force investigation of Casmalia Resources in 1986. The Project Plan has been incorporated into this report by reference. For a thorough review of the procedures used in this investigation and for a comprehensive understanding of the results of this report, the Project Plan should be consulted.

1. Facility Inspection/Record Review

The facility inspection involved three major areas: collection and review of all pertinent data and documents relating to the facility design and operation; interviews of facility personnel; and inspections of facility units; operations and disposal areas.

In March 1987 Planning Research Corporation (PRC) Chicago, Illinois, under contract to U.S. EPA Headquarters and the Task Force, compiled an information/document package for the Hughes Aircraft Facility. The PRC file consists of 14 volumes containing a catalogue of all documents and correspondence regarding the facility from EPA and State files. The PRC file was used as a comprehensive review and reference document to aid in this investigative process. Documents and records were also reviewed and collected at the facility to verify information currently in Government files and to supplement them with new information. Documents requested of the facility were those known to be missing from Government files, new information, documents not yet received by the Agency, and documents of interest brought to our attention through interviews with facility personnel. All documents are on file with EPA Region 9.

Interviews of facility personnel and their contractors were conducted throughout the investigation. The kickoff meeting, held the first morning of the field investigation at the facility offices, involved four facility representatives as well as Task Force, Regional, and State representatives. Several other interviews were held with selected facility personnel throughout the investigation. All interviews were attended by State and/or Region 9 Superfund representatives.

Discussions from the meetings and interviews were documented in field log books issued to each Task Force participant. Notebooks were issued to Task Force, Versar, Regional and State participants to document and log all activities observed and conducted during the investigation. All notebooks were collected at the end of the investigation, used in the report writing, and are kept on file at Region 9.

Investigation of facility waste management units were also conducted during the Task Force investigation. This included current operating units, past disposal areas, and Superfund sources. Between interviews with facility personnel, review of aerial photographs, and walking and drive-through reconnaissance, several previously undisclosed disposal areas, or Solid Waste Management Units (SWMU's), were discovered.

This information was used to conduct a RCRA Facility Assessment (RFA) as required by the RCRA permitting process. In August 1987 the Visual Site Inspection (VSI) portion of the RFA was conducted by EPA contractor A.T. Kearney. The VSI was attended by Region 9 Permits, Inspection, and CERCLA personnel, and State personnel. The results of the RFA are presented in a report developed by Kearney which was completed in September 1987.

Photo documentation of facility units and operation, Task Force sampling operations, and facility sampling procedures was conducted. Photography by Task Force representatives was prohibited by the facility for security purposes. All photographs were taken by facility representatives. Selected photographs were then sent to the Task Force after security review. The photo package sent by the facility is incorporated into the Sampling Audit and Sampling and Documentation Reports by reference.

2. Sampling Audit

In order to assess the facility's ground water sampling procedures, EPA audited a facility sampling demonstration given by the facility sampling contractor, Hargis and Associates. The sampling demonstration was limited to one well and two parameters and was given on April 22, 1987. The audit included observation of sampling procedures, interviewing sampling personnel, and collection of sampling-related documents.

The neutron probe system, used by the facility to meet the conditions of the 1984 consent agreement with EPA, was also investigated by the Task Force. A demonstration of the operation of the probe system was arranged with the facility contractor who operates the system. This audit included observation of the probe procedures, interviewing the probe operators, collection of pertinent documents, review of the operation plan, and photo-documentation. Aldo Mazzella with EPA Environmental Systems Monitoring Laboratory in Las Vegas conducted a review of the neutron probe system for the Task Force. His report is attached as Appendix B of this report.

3. Sampling Program

One of the objectives of the Task Force investigation at Hughes Aircraft/Air Force Plant #44 was to sample selected facility wells and analyze them for the RCRA indicator and Appendix IX parameters, identified in Appendix A. The intent was to provide an indication of the quality of the ground water beneath the site in the vicinity of the RCRA units and to compare and confirm the results with information provided by the facility.

All but one of the selected wells were CERCLA monitoring wells, rather than RCRA wells. The selection of the wells was based on an attempt to confirm past data and expand the number of parameters analyzed for around the facility units. The selection was not based on an attempt to determine releases from the RCRA units. Due to improper well placement and construction, and possible releases from SWMU's in the area, it would be impractical to make determinations of releases from the regulated units without further investigation.

From April 20 to 23, 1987 six facility wells were sampled (well locations are shown in Figure 5). In addition, five blank samples and one replicate sample were taken, for a total of 11 samples. Split samples were provided to the facility. A four-person sampling team from Versar and Planning Research Corporation performed all the sampling.

The sampling activities were based upon the April 1987 Sampling and Analysis Plan (Schultz, 1987). Sampling procedures are described in detail in the Sampling and Analysis Plan, Attachment A of the Project Plan. Descriptions of the sampling protocol, container and preservative details, shipping, and QA/QC procedures are described in the Sampling Plan. The reader is referred to the Sampling Plan and the Sampling Documentation Report, October 1987, for details of the procedures used during the investigation. These reports are on file at the Region 9 office.

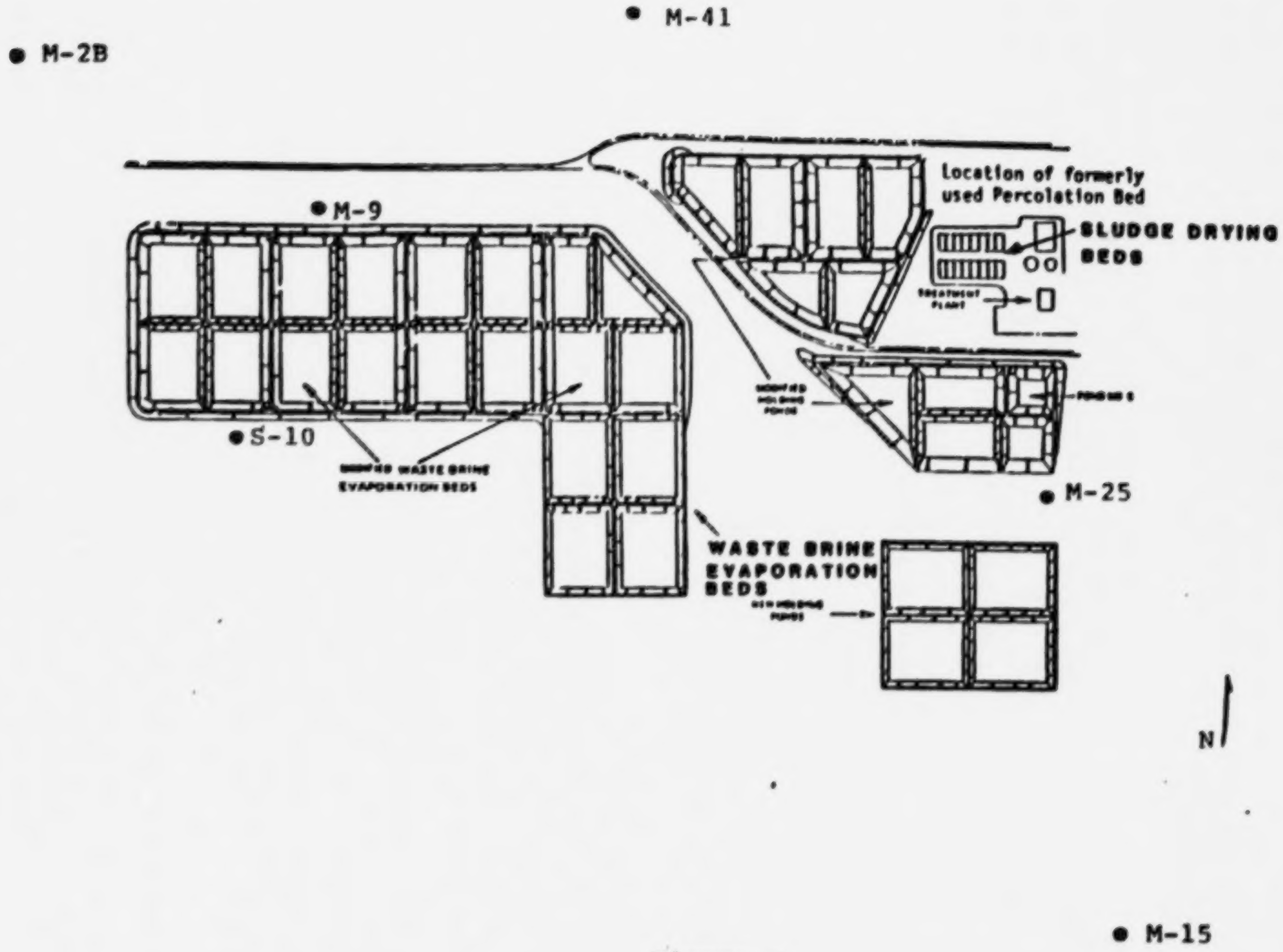

M-2B
M-41
M-9
S-10
Location of formerly
used Percolation Bed
SLUDGE DRYING
BEDS
TREATMENT PLANT
MODIFIED HOLDING PONDS
MODIFIED WASTE BRINE
EVAPORATION BEDS
M-25
WASTE BRINE
EVAPORATION
BEDS
N
M-15

Figure 5

Relative locations of wells sampled during Hughes/AFP £44 Task Force investigation

(Not to Scale)

C. WASTE MANAGEMENT UNITS AND OPERATIONS

1. Current RCRA Units

The RCRA regulated units at Hughes/AFP #44 are process units within the Industrial Wastewater Treatment Plant (IWTP). The IWTP is designed to be a zero discharge facility designed to recycle 75% of the (treated) industrial wastewater back into the industrial water supply. The IWTP includes a control building, filter building, two tank batch treatment systems, a sludge dewatering facility, and a 33-acre secured area containing 15 holding ponds and 20 evaporation beds (see Figure 5 above).

The following listed hazardous wastes are received at the IWTP: spent cyanide plating bath solutions from electroplating operations (F007); plating bath sludges from electroplating operations (F008); and spent stripping and cleaning bath solutions from electroplating operations (F009). In addition, two characteristic waste streams containing chromium (D007) and lead (D008) are received at the IWTP.

The IWTP produces several liquid waste streams as well as reclaimed water. The wastes include: waste brine from a reverse oxidation (RO) system; scum and sludge from a dissolved air flotation (DAF) system and reactor-clarifier units; treated alkaline waste; treated acid waste; and filter backwash cleaning waste. The brine from the RO system and the treated alkaline and acid wastes are piped to the brine evaporation beds. The DAF sludge and scum, reactor-clarifier sludge, and filter backwash cleaning waste are piped to the sludge dewatering facility.

Batch Treatment Systems

There are two batch treatment systems at the IWTP. One is used to treat concentrated acid waste (CAW), the other to treat concentrated alkaline solutions (CAS). Both systems employ similar equipment and processes. Both systems discharge treated waste to the waste brine evaporation beds.

The CAW reduces Cr-VI to Cr-III using sulfur dioxide under acidic conditions. The Cr-III is then precipitated out using sodium hydroxide under alkaline conditions.

The CAS oxidizes cyanide to cyanate using chlorine under alkaline conditions. The cyanate is then oxidized to carbon dioxide and nitrogen gas using chlorine under alkaline conditions.

Waste Brine Evaporation Beds

Twenty double-lined evaporation beds are on line at the IWTP. These beds receive waste from the RO system, treated alkaline and treated acid waste, and waste monoethanolamine. Annual waste brine production at the IWTP is estimated at 40 million gallons. Annual salt accumulation in the beds is estimated at 0.1 - 0.2 inches/yr.

The beds are constructed with two 100 mil High Density Polyethylene (HDPE) membranes separated by a drainage net. Each bed contains a leak detection system using a collector pipe fed by the drainage net between the HDPE membranes.

Holding Ponds

Fifteen wastewater holding ponds are on-line at the IWTP. These ponds store general industrial waste during periods of high flow or IWTP shut down. The ponds have the same construction as the brine ponds.

Sludge Dewatering Facility

This unit consists of a thickening tank and a plate and frame filter press. Sludge and scum from the DAF, sludge from the reactor-clarifier units, and backwash cleaning wastes are piped to the thickening tank and then to the press. The filter cake is sent to a hazardous waste landfill, the filtrate is sent to the DAF clarifier.

2. Solid Waste Management Units (SWMU's)

Based on investigations conducted during the Task Force inspection and a RCRA Facility Assessment (RFA) conducted in August 1987 by A.T. Kearney, an EPA contractor, 164 Solid Waste Managemant Units have been identified at the facility. Several of these units are known to be contributing to ground water contamination at the facility while many others are suspected or could be potential sources of contamination. Several SWMU's were discovered during the Task Force investigation that had not been reported to EPA by the facility as is required under CERCLA.

Several problems were encountered during the RFA which made it difficult to identify and characterize all the SWMU's at the facility. In several areas EPA was denied access due to security reasons. Recent construction and removal operations also obscured attempts to identify units. The facility's reluctance to provide information on several areas also made investigations difficult.

It was also noted that the not all SWMU's were investigated under the Air Force Remedial Investigation (RI) and IRP. It was concluded in the RI that no continuing sources of ground water contamination existed at the facility despite the existence of over 100 SWMU's.

Some of the major solid waste management units so far identified at the facility include the following:

a) Twelve unlined pits which received methylene chloride, TCE, TCA, other solvents, paint sludges and thinners;

b) Unlined wastewater ponds which received plating rinsewaters, cooling tower blowdown, concentrated solutions of cyanide and chromium;

c) Two sludge drying beds. One lined with a plastic membrane, the other lined with bentonite. These beds received wastewaters containing chromium, cyanides, cadmium, silver, lead, copper compounds, and heavy metal sludges;

d) Unlined drainage channels which led to the Arroyo Wash at the Nogales Highway. These channels received wastewaters from the unlined wastewater ponds as well as chrome and cyanide-free rinsewater, acid solutions after batch treatment, and batch treated chrome and cyanide containing wastewaters, paint booth wash, cooling blowdown;

e) Three fire training areas where alcohols and flammable solvents, including acetone and MEK, were discharged directly onto the ground;

f) An unlined explosive pit where ordnance was detonated;

g) Numerous below and above ground storage tanks containing solvents, oils, gasoline, and diesel fuel.

Based on the results of the work performed under the RFA, several inactive units appear to warrant soil sampling and investigations to verify contamination and to delineate the horizontal and vertical extent of contamination. These are: Inactive Landfill Site 1 (Unit 100), Inactive Landfill Site 2 (Unit 101), Inactive Surface Impoundment Site 4 (Unit 103), Inactive Surface Impoundment Site 5 (Unit 104), Inactive Fire Training Area East of Building 811 (Unit 107), Inactive Fire Training Area in FACO Area (Unit 108), Inactive Fire Training Area West of Building 801 (Unit 109), Magnesium Disposal-Ignition Area (Unit 110), Explosion Pit (Unit 111), Trash Pile (Unit 112), Fill Material Area (Unit 113), and Ditches (Unit 164).

All the SWMU's at the facilty must be addressed, as well as any ground water contamination, before a final permit can be issued under RCRA. These units must be addressed either under RCRA or CERCLA authorities.

Details on all the SWMU's at the facility are presented in the Hughes/AFP #44 RFA report developed by A.T. Kearney, September 1987. This report is part of the Region 9 file on Hughes Aircraft, Air Force Plant #44.

D. SITE GEOLOGY/HYDROGEOLOGY

1. Geomorphology

Hughes Aircraft/Air Force Plant #44 lies 15 miles south of downtown Tucson (latitude 32° 06' 00", longitude 110° 55' 44"). The facility is bordered to the north by Tucson International Airport, bordered to the west by the San Xavier Indian Reservation, and bordered to the south and east by undeveloped land.

The altitude of Hughes/AFP #44 is approximiately 2,600 feet above mean sea level (msl). This facility lies on relatively flat terrain with 60 feet of relief over two miles (maximum slope of less than one percent towards the northwest).

The facility is located in the Tucson basin, which is within the Sonoran Desert section of the Basin and Range physiographic province. This province is generally characterized by north to northwest trending fault-block mountains separated by either desert plains or broad gently sloping alluvial basins. The basin covers approximately 1,000 square miles. To the north and east are the Santa Rita, Empire, Rincon, Tanque Verde and Santa Catalina Mountains. To the west are the Sierrita, Black, and Tucson Mountains (USGS 86-4313). The eastern and northern ranges are at altitudes between 6,000 and 8,000 feet above msl, with peaks greater than 9,000 feet above msl. The ranges to the west are between 3,000 and 6,000 feet above msl.

The Tucson basin is drained by the Santa Cruz River, which flows to the northwest through the basin. Major tributaries to the Santa Cruz River in the vicinity of Hughes include Julian Wash, Pantano Wash, Arroyo Wash, and Rillito Creek. All the tributaries flow to the west or northwest, toward the Santa Cruz River. These drainage ways are dry most of the year, flowing only during and immediately after rainstorms.

Surface flow on the plant property is controlled by two intermittent streams, a series of drainage channels, and a subsurface storm drain system (SAIC, 1985). General surface drainage is west and northwesterly toward the Santa Cruz River. There are two intermittent streams on the plant property, one through the southern portion of the property, the other through the northwest portion of the property. These streams meet and drain to the west toward Nogales Highway. The storm drain system at Hughes/APF #44 directs surface runoff from the main facility area to drainage channel which runs west, in the direction of the river (SAIC, 1985).

2. Geology

The mountains surrounding the Tucson basin are comprised of crystalline igneous, metamorphic, volcanic, and sedimentary rocks. Ages vary from Precambrian to late Tertiary (SAIC, 1985). The basin is filled with several thousand feet of sediments (alluvium) which are derived from the surrounding mountain ranges (Figure 6). These deposits are considered to be less than 13 million years old. The major alluvium sources consist of granite, granite-gneiss, schist, andesite, basalt, and limestone. The sediments are interbedded locally with volcanic flows, agglomerates, and tuffaceous sediments.

These basin fill deposits are characterized by the following:

a) They retain their original depositional slopes

b) They contain facies relationships largely consistent with present configurations of the basin.

c) They are only locally deformed by tectonics.

d) They rest upon a Middle Miocene unconformity.

The basin fill includes four sediment groups (Figures 7 & 8)

1) surficial deposits

2) the Fort Lowell Formation

3) the Tinaja Beds

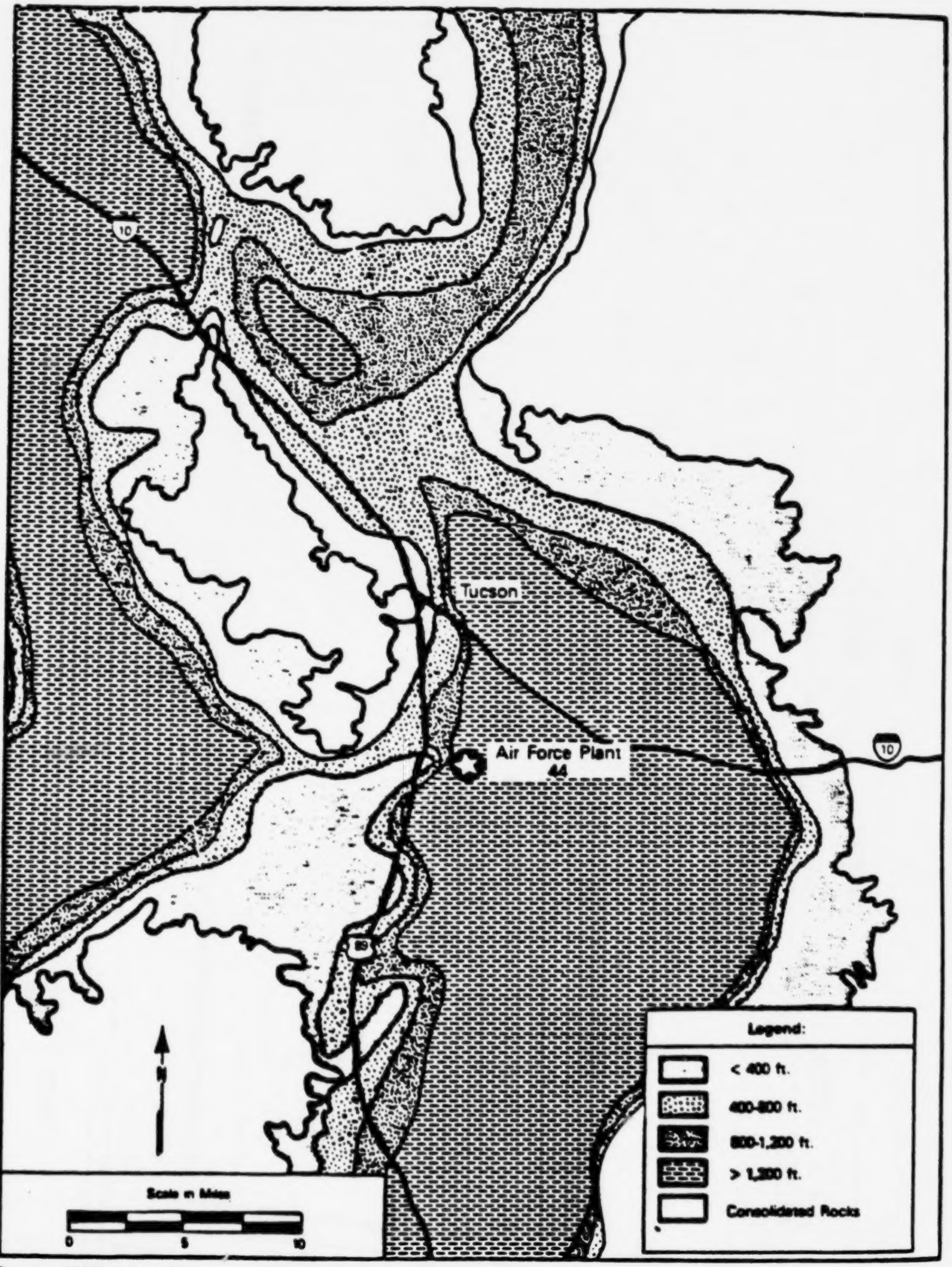
4) the Pantano Formation

Surficial Deposits

The surficial deposits are thin, discontinuous terrace gravels, stream channel and floodplain deposits which overlie the Fort Lowell Formation. These deposits are mainly gravel, gravelly sand, and localized sand and sandy silt. These deposits range in thickness from featheredge to several tens of feet.

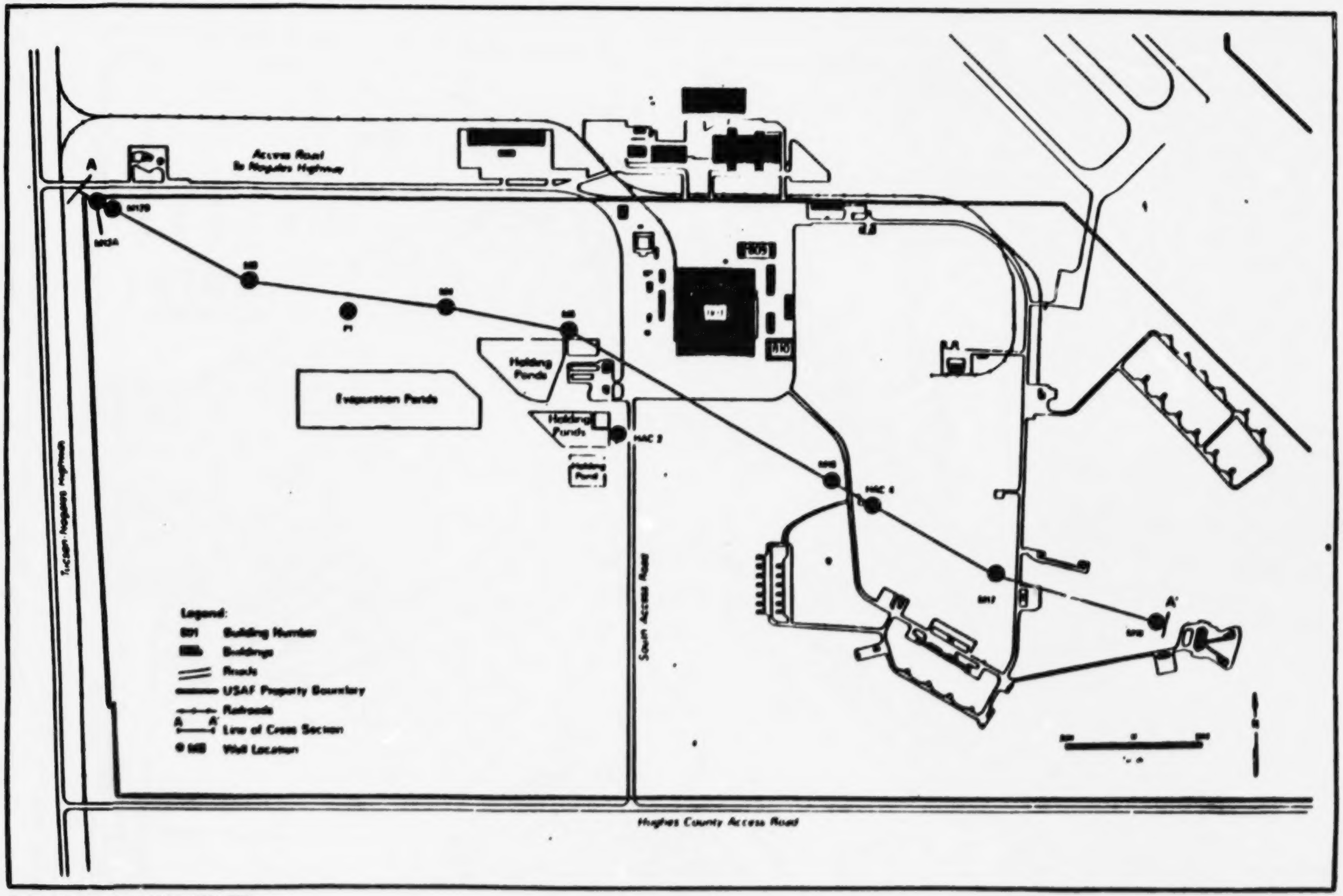
Fort Lowell Formation

This formation, overlying the Tinaja Beds, is comprised of predominantly silty gravel near the basin margins, grading to a silty sand and clayey silt in the center of the basin. The Fort Lowell Formation is 300 to 400 feet thick in the center of the basin (Hargis & Montgomery, 1982). This formation is estimated to be of Quaternary age.


10
Tucson
Air Force Plant 44
10
89
N
Scale in Miles
0
5
10
Legend:
< 400 ft.
400-800 ft.
800-1,200 ft.
> 1,200 ft.
Consolidated Rocks

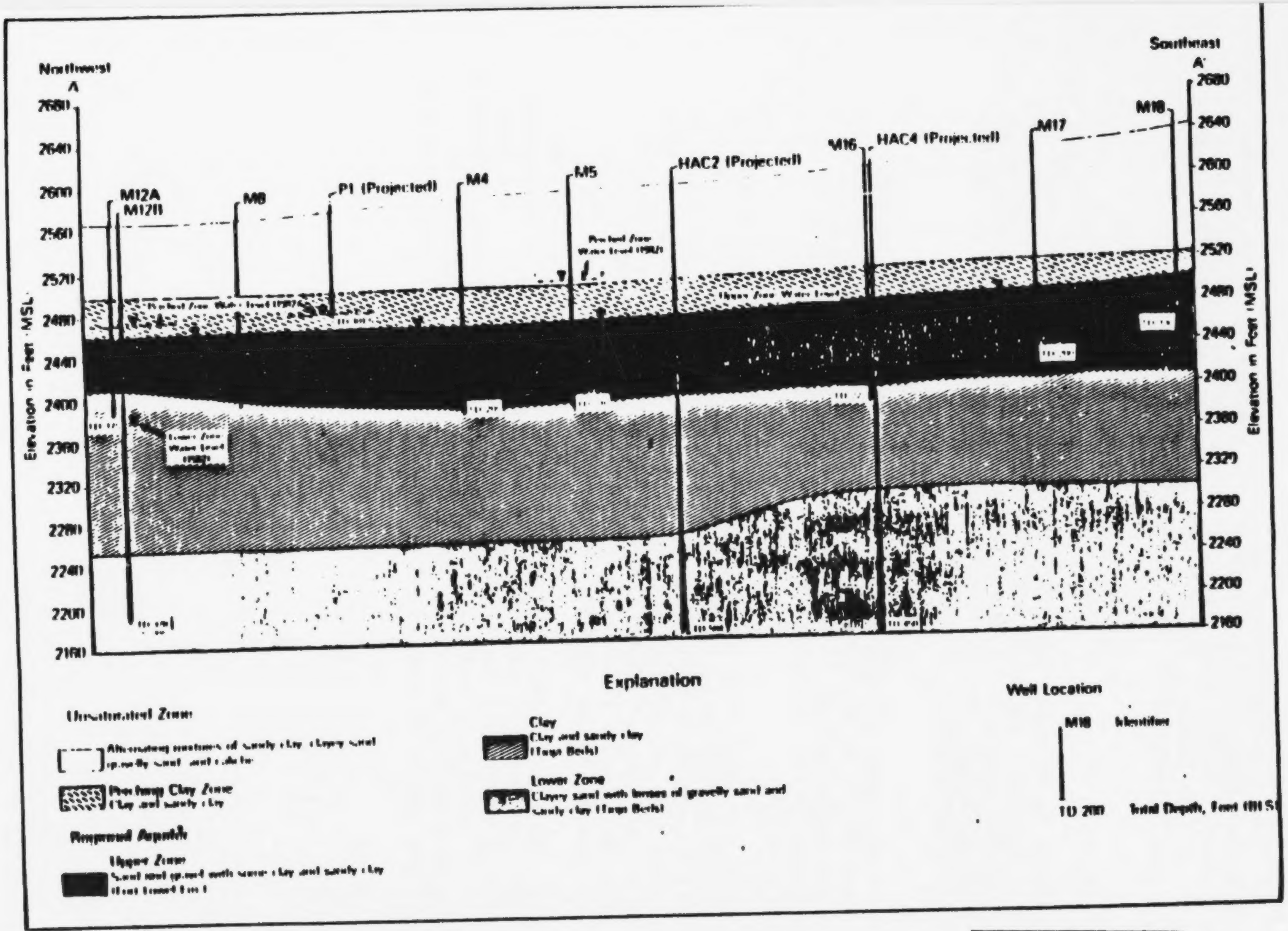
Source: CH2M Hill, 1982

Figure 6 Geologic Map Showing Distribution and Estimated Thickness of Unconsolidated Sediments in the Area of AFP 44, Tucson, Arizona


Access Road
to Nogales Highway
A
A'
HAC 2
HAC 4
P1
Holding Ponds
Holding Ponds
Holding Pond
Evaporation Ponds
801
805
810
South Access Road
Hughes County Access Road
Tucson-Nogales Highway
Legend:
801 Building Number
Buildings
Roads
USAF Property Boundary
Railroads
A A' Line of Cross Section
● M8 Well Location

Source: Information extracted from HAR, 1982b

Figure 7 Location of Cross-Section Line A-A' at AFP 44, Tucson, Arizona (see Figure 8 for cross-section)


Northwest
A
Southeast
A'
Elevation in Feet MSL
Elevation in Feet (MSL)
2680
2640
2600
2560
2520
2480
2440
2400
2360
2320
2280
2240
2200
2160
M12A
M12B
M8
P1 (Projected)
M4
M5
HAC2 (Projected)
M16
HAC4 (Projected)
M17
M18
Explanation
Clay
Clay and sandy clay
Perching Clay Zone
Clay and sandy clay
Lower Zone
Upper Zone
Well Location
M18
TD 200
Total Depth, Feet

Source: [illegible]

Reproduced from best available copy.

Figure 8 Geologic Cross-Section A-A' Across AFP 44, Tucson, Arizona (see Figure 7 for cross-section location)

Tinaja Beds

The Tinaja Beds range in thickness from a featheredge to greater than 5,000 feet. These beds are comprised of sand and gravel at the margins of the basin. In the center of the basin they grade to gypsiferous, clayey silt and mudstone.

Pantano Formation

This formation is a silty sandstone that includes gravel with interbedded volcanic flows and tuffaceous sediments. The Pantano formation is estimated to range from a few hundred to 1,000 feet (Hargis & Montgomery, 1982). This formation was dated as middle Tertiary by Finnel (USGS, 86-4313).

The central part of the Tucson basin is a triangular down-faulted block which is bounded by the Santa Cruz fault, an unnamed fault running parallel to Rillito and Tanque Verde Creeks, and another unnamed fault trending northeast through the basin (Hargis & Montgomery, 1982).

The alluvial deposits at Hughes/AFP #44 vary due to differences in depositional environments. Fine grained sediments such as silts and clays were deposited as river mouth alluvial fans or on terraces at low water velocities during flood stages as rivers overflowed their banks. Coarser materials such as sands and gravels were deposited in stream beds. These sediments were distributed laterally as streams changed course (SAIC, 1985).

Hargis and Montgomery (1982) found the upper 175 to 225 of alluvium at the facility to correlate to the Fort Lowell Formation. The underlying sediments have been drilled to a depth of 600 feet and appear to correlate with the Tinaja Beds. The entire thickness of the Tinaja Beds has not been penetrated by drilling at the facility. The depth of the underlying Pantano Formation is unknown.

3. Soils

The Soil Conservation Service (SCS) has identified five distinct soils in the vicinity of Hughes:

1) The Cave series, a shallow, well-drained, moderately permeable soil, commonly formed in gravelly mixed alluvium on low hills and valley fill;

2) The Yaqui series consists of deep, well-drained soils formed in mixed, calcareous alluvium on alluvial fans;

3) The Nickel series consists of deep, well-drained soils formed on dissected terraces in alluvium that originated from mixed rock sources;

4) The Sahuarita series consists of deep, well-drained soils formed on alluvial fan terraces in mixed calcareous alluvium; and

5) The Riggs series consists of deep, moderately well-drained, low permeability soils that form in mixed alluvium on alluvial fans and flood plains.

4. Hydrogeology

The regional aquifer in the Tucson basin has been classified into three zones by Hargis & Montgomery (Phase I, 1982), upper zone, a lower zone, and an area where the two merge called the undivided aquifer. Under the facility Hargis & Montgomery claim the aquifer is divided into an upper zone and a lower zone, separated by an extensive clay confining layer (aquitard). Where this confining layer does not exist, the aquifer is classified as undivided. The undivided portion of the aquifer is reported not to exist under the facility. In addition to the aquitard there is a perched lens of approximately 100 acres under the facility. The upper zone and the lower zone are assumed to be hydrogeologically connected. Only regional site characerization has been conducted, and no site characterization report has been submitted for the RCRA Part B permit application.

a. Water bearing zones

Perched Zone

This zone lies approximately 60-95 feet below the surface. The thickness of the perched lens varies from approximately 1 to 5 feet. This zone is comprised primarily of sandy clay and clay. The sandy clay pinches out north of the plant. Water levels in this zone appear to fluctuate in response to rainfall and runoff events. Hargis and Montgomery (1987) have concluded that this lens is recharged from percolation of runoff along a network of arroyos and from runoff ponding in low areas.

Upper Aquifer Zone

The upper aquifer zone extends approximately from 100 to 200 feet below the surface. This zone is comprised of fine-to-coarse sand with gravel, occassional lenses of cobbles, and lenses of clay (Hargis & Montgomery, 1982).

Lower Aquifer Zone

The lower aquifer zone extends from 200 feet to a depth of approximately 600 feet below the surface. This zone is comprised of clayey sediments interbedded with lenses of sand, sandy clay, and clayey sand.

b. Occurrence and Movement

Ground water occurs under unconfined conditions in both the perched zone and the upper zone of the regional aquifer system. In the lower zone of the regional aquifer, groundwater occurs under semiconfined conditions (Hargis & Montgomery, 1982).

The direction of flow in both the upper and lower zones beneath the facility is to the northwest. The hydraulic gradient for the upper zone is approximately 15 feet per mile. In the perched zone groundwater flow radiates away from a central mound.

Ground water is the principle source of irrigation, municipal, industrial, and domestic water in the Tucson basin. Pumping rates have exceeded recharge rates, and substantial declines in water levels have occurred in the northern and southwestern parts of the basin. Most of the recharge to the ground water flow system in the alluvial aquifer is derived from infiltration along the major stream channels and from mountain-front recharge.

5. Climate

The climate of the Tucson area is characterized by warm semi-arid conditions associated with low latitude deserts. Mean annual precipitation is approximately 11.2 inches. Mean relative humidity is 37.5%. The net precipitation for this area (mean annual precipitation minus mean annual evaporation) is minus 55 inches per year. The annual average temperature is 68°F.

E. INTERIM STATUS GROUND WATER MONITORING

1. Current Monitoring System

Over 100 ground water monitoring wells currently exist at the Hughes/AFP #44 facility; however, not all are designated as RCRA monitoring wells. The first RCRA Part B Permit Application was submitted in August 1983. In that application the facility claimed an exemption from the ground water monitoring program because the impoundments were lined. The facility supported the waiver with data obtained from a neutron probe system. Consequently, the application contained no interim status ground water monitoring data.

In response to an inspection conducted in August 1982, a complaint was issued to the facility in June 1983 asserting that the neutron probe system was not capable of detecting leakage from the ponds and that the facility could not support the claimed ground water monitoring waiver. EPA also determined that the neutron probe system did not constitute an acceptable alternative ground water monitoring system.

In the intervening months, EPA Region 9 staff and the facility agreed upon improvements to the neutron probe system and installation of the 19 S-series wells to monitor the perched zone. This allowed the facility to use the perched zone/neutron probe system as an alternative ground water monitoring system. The facility, however, refused to pay the requested $17,000 penalty. This led to a referral of the case to the U.S. Department of Justice (DOJ) in March 1984 and an Administrative Hearing, with an Administrative Law Judge in May 1984.

The results of the Administrative Hearing upheld Hughes' contention that, because they were acting under contract to the Air Force as a GOCO, they were considered to be a federal facility and therefore not subject to any fines levied by EPA. Consequently, the DOJ referral was also retracted and a Federal Facility Compliance Agreement (FFCA) was signed with no penalty.

In July 1984, EPA issued the first NOD for the August 1983 Part B submittal. The revised Part B was received in December 1984. An additional Part B revision was submitted in January 1987; however, it was a result of process changes at the facility and not a NOD. The ground water portion of the January 1987 Part B was identical to the December 1984 version. That version of the Part B application was the one in effect at the time of the Task Force investigation.

The present RCRA monitoring system consists of 26 perched zone wells (Figure 9) and 30 neutron probes (Figure 10). The FFCA requires the facility to sound perched zone wells B3, B6, B7, B9, B19, C3, P8, and all S-series wells monthly. Whenever a well shows a water level rise of over one foot, that well must be

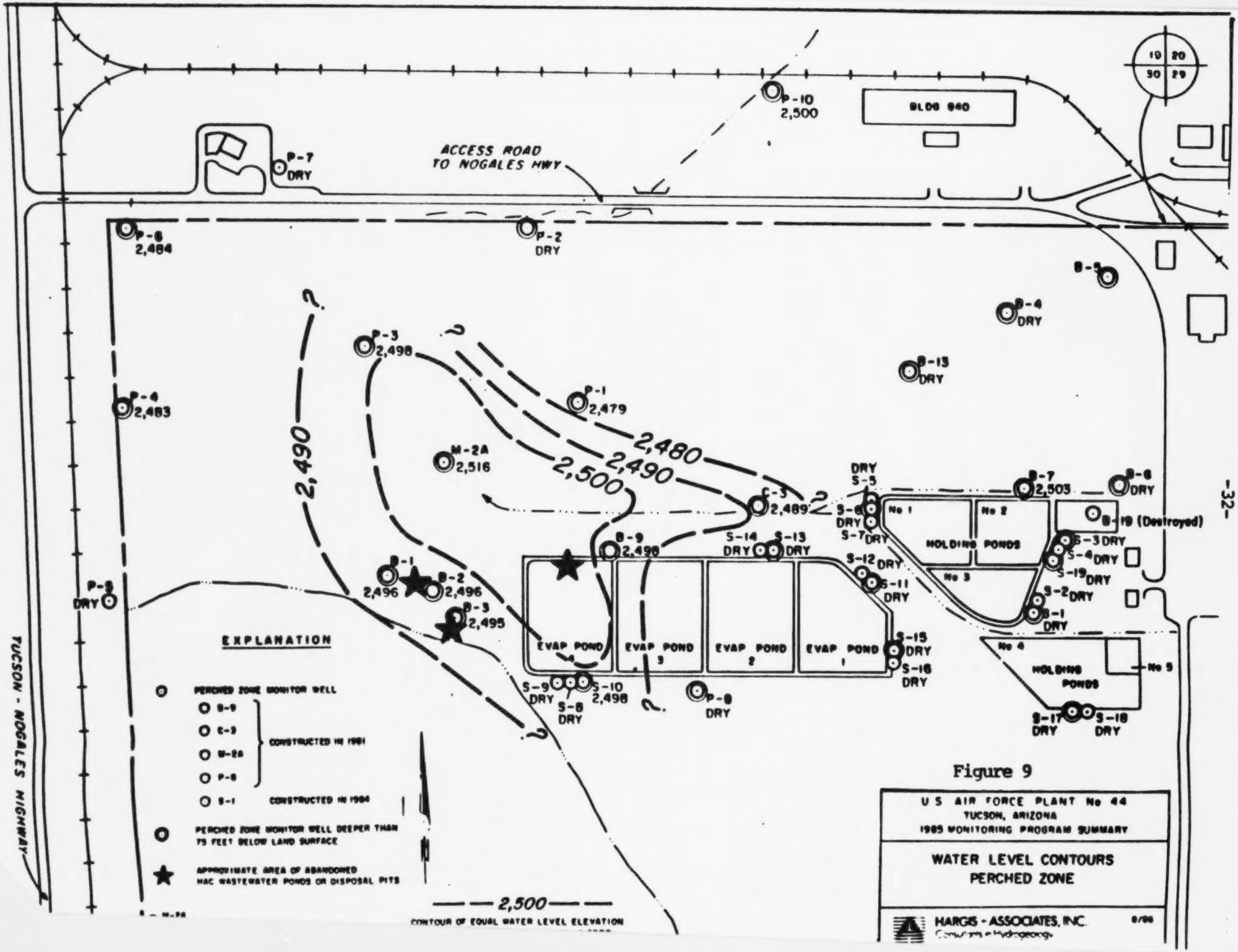

BLDG 840
ACCESS ROAD
TO NOGALES HWY
TUCSON - NOGALES HIGHWAY
10 20
30 29
P-10
2,500
P-7
DRY
P-6
2,484
P-2
DRY
P-4
2,483
P-3
2,498
P-1
2,479
M-2A
2,516
P-5
DRY
B-1
2,496
B-2
2,496
B-3
2,495
B-9
2,498
C-3
2,489
B-13
DRY
B-4
DRY
B-5
B-7
2,503
B-8
DRY
B-19 (Destroyed)
DRY
S-5
S-6
DRY
S-7 DRY
S-14
DRY
S-13
DRY
S-12 DRY
S-11
DRY
S-3 DRY
S-4 DRY
S-19 DRY
S-2 DRY
S-1
DRY
S-15
DRY
S-16
DRY
S-9
DRY
S-8
DRY
S-10
2,498
P-8
DRY
S-17
DRY
S-18
DRY
No 1
No 2
HOLDING PONDS
No 3
No 4
HOLDING
PONDS
No 5
EVAP POND
4
EVAP POND
3
EVAP POND
2
EVAP POND
1
2,480
2,490
2,500
2,490
?
EXPLANATION
PERCHED ZONE MONITOR WELL
B-9
C-3
M-2A
P-8
CONSTRUCTED IN 1981
S-1
CONSTRUCTED IN 1984
PERCHED ZONE MONITOR WELL DEEPER THAN
75 FEET BELOW LAND SURFACE
APPROXIMATE AREA OF ABANDONED
HAC WASTEWATER PONDS OR DISPOSAL PITS
2,500
CONTOUR OF EQUAL WATER LEVEL ELEVATION
HARGIS - ASSOCIATES, INC.
Consultants in Hydrogeology
8/86

Figure 9

U S AIR FORCE PLANT No 44
TUCSON, ARIZONA
1985 MONITORING PROGRAM SUMMARY

WATER LEVEL CONTOURS
PERCHED ZONE

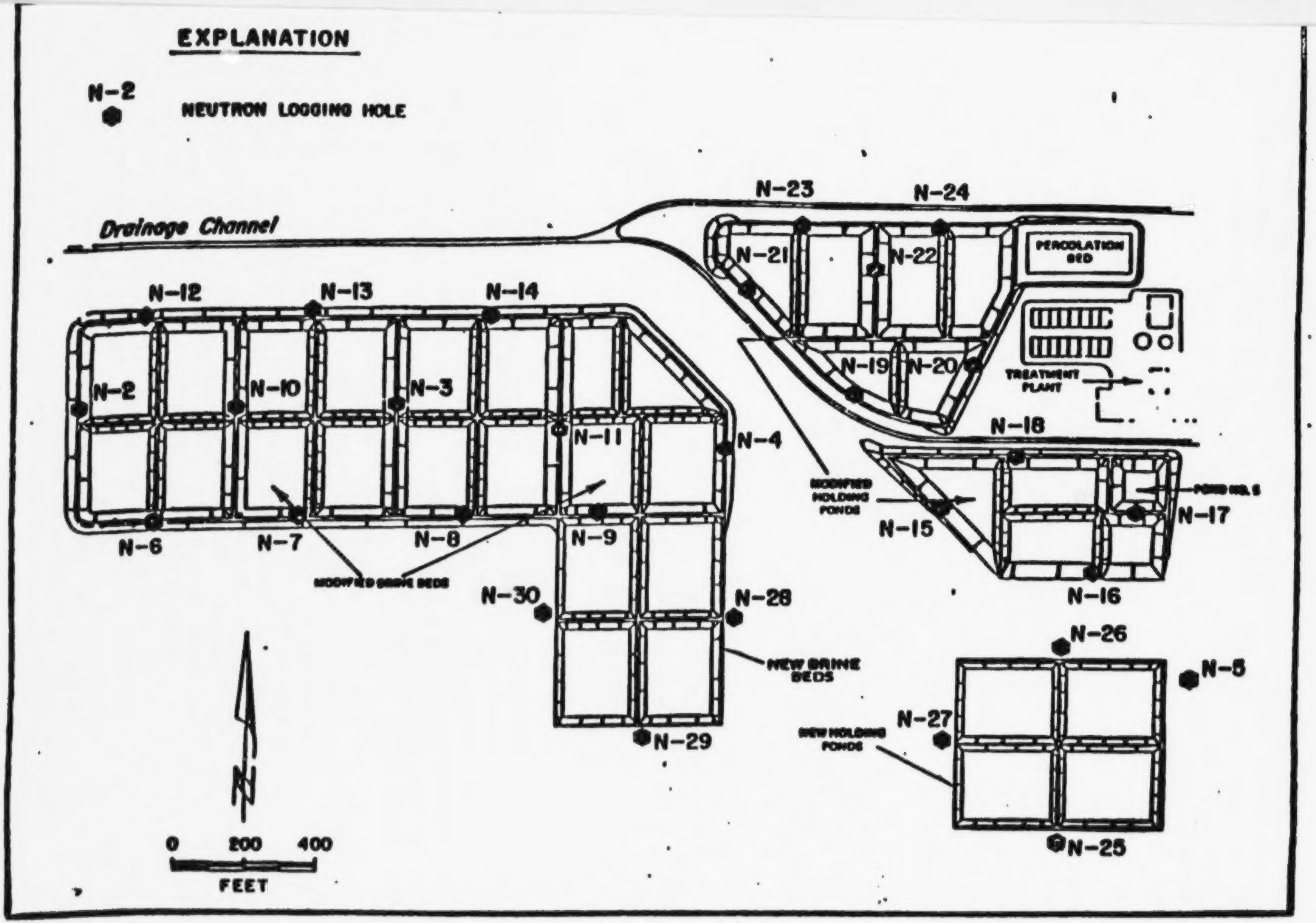

EXPLANATION
N-2
NEUTRON LOGGING HOLE
Drainage Channel
N-12
N-13
N-14
N-2
N-10
N-3
N-11
N-4
N-6
N-7
N-8
N-9
MODIFIED BRINE BEDS
N-30
N-28
NEW BRINE BEDS
N-29
N-23
N-24
N-21
N-22
PERCOLATION BED
N-19
N-20
TREATMENT PLANT
N-18
MODIFIED HOLDING PONDS
N-15
POND NO. 5
N-17
N-16
N-26
N-5
N-27
NEW HOLDING PONDS
N-25
N
0
200
400
FEET

FIGURE 10 LOCATION MAP FOR NEUTRON LOGGING HOLES

sampled for chromium, nickel, copper, and sulfates. All of the above wells are required to be sampled (if not dry) on a quarterly basis. No statistical analysis has been conducted on the data generated from these samples. The neutron probe system is also monitored on a quarterly basis.

Perched zone wells generally consist of 2 or 3 inch PVC pipe, capped and slotted at the base with pea gravel filter pack, and cemented inside a 6 inch surface casing (see Figure 11). These wells do not meet current design or construction standards for RCRA monitoring wells. The wells contain excessive screen lengths, contain no annular seal, do not contain a filter pack matched to the aquifer material, and do not monitor the uppermost aquifer system as is required. The monitoring system is also not based on an adequate hydrogeologic site characterization plan.

The neutron probe system consists of 30 neutron logging holes. The neutron holes are constructed around the 20 brine evaporation beds and the 15 holding ponds. Fifteen probes surround the evaporation beds, 14 probes surround the holding ponds. The quarterly logs are compared to previous logs to determine if there has been an increase in soil moisture content.

The effectiveness of the system is based on the assumption that any flow from a pond leak will be in the horizontal direction. The radius of influence for neutron probes is very limited. Any liquid that leaves the ponds must come within the.radius of influence of the probe in order to be measured. The probes are logged on a quarterly basis, so the assumption is that any migrating liquid will move horizontally, and will remain in the unsaturated zone until the the logging event.

Review of the system by technical staff of the EPA Environmental Monitoring Systems Laboratory (EMSL) in Las Vegas has revealed the system to be inadequate and undemonstrated as to its capability to meet its designed intent. It was determined that a number of aspects of the neutron probe system need to be investigated before the system could be considered acceptable for a leak detection.

The effects of the casing material and grout on the probe sensitivity and detectability has not been determined. The cement used in the annulus of the access tube contains about 33% water which affects the sensitivity of the system. It should also be established that no leaks existed from the ponds before the monitoring of the system was initiated. Since all the access tubes were not in place before the evaporation ponds, it cannot be determined what pre-pond background conditions were and whether existing log moisture contents reflect existing long term leaks. The system also relies on the existence of continuous layers of clay and caliche to produce lateral movement of releases in the vadose zone. The continuity of these layers had not been established, nor has any direction been suggested for this lateral movement. Finally, some modeling of unsaturated zone flow is needed to provide a leak detection confidence level for the system. The complete EMSL report is attached as Appendix B.

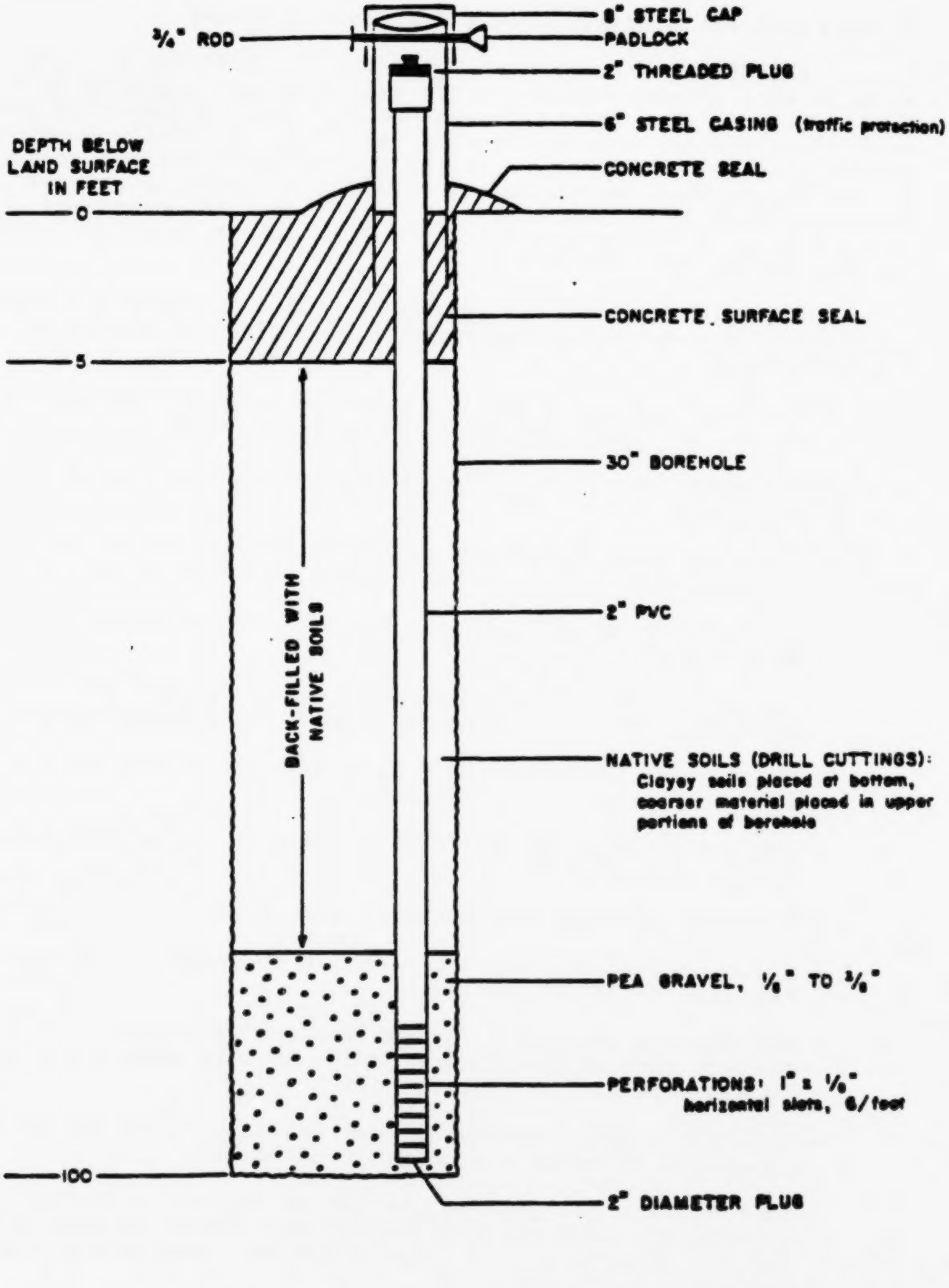

8" STEEL CAP
¾" ROD
PADLOCK
2" THREADED PLUG
6" STEEL CASING (traffic protection)
DEPTH BELOW LAND SURFACE IN FEET
CONCRETE SEAL
0
CONCRETE SURFACE SEAL
5
30" BOREHOLE
BACK-FILLED WITH NATIVE SOILS
2" PVC
NATIVE SOILS (DRILL CUTTINGS): Clayey soils placed at bottom, coarser material placed in upper portions of borehole
PEA GRAVEL, ⅛" TO ⅜"
PERFORATIONS: 1" x ⅛" horizontal slots, 6/foot
100
2" DIAMETER PLUG

FIGURE 11 SCHEMATIC DIAGRAM OF MONITOR WELLS CONSTRUCTED IN THE PERCHED ZONE (From Hargis, Phase II)

2. Sampling and Analysis Plan and Field Procedures

The sampling demonstration given by the facility at well M-2A as part of our sampling audit cannot be extrapolated to a full-scale sampling effort because of the limited number of field conditions and procedures actually observed. A detailed review of the sampling procedures observed during the audit is provided in the Ground Water Sampling Audit report prepared by Frances Schultz, April 1988. As with the other supporting documents and reports, it is incorporated into this report by reference and is part of the Task Force file.

The sampling procedures conducted by the facility and their contractor were generally inadequate. Deficiencies included the following:

- The well was not inspected prior to sampling (animal borings at the well pad were observed by the auditor)
- The water level indicator was not decontaminated after samplings.
- Depth to water and depth to bottom of well (sounding) is not generally taken at every sampling event prior to purging.
- Gloves were not worn throughout most of the purging and sampling procedure.
- Casing volume (used to determine purge volume) was calculated using historical data rather than a field measurements.
- Purge water (potentially a hazardous waste) has been disposed of onto the ground in the past.
- The bailer line was observed to contact the ground during the bailing process.
- A ground covering was not used around the base of the well.
- Field parameters were not measured in quadruplicate as required in 40 CFR 265.93(b).
- PVC bailers were used for purging and sampling, rather than bailers made of inert materials. Bailers were not constructed to minimize sample disturbance.
- Volatile organic compounds were collected last and allowed to aerate as water was poured from bailer.
- Samples were not sent to the lab as "blind". Identification of the well was provided on the labels, giving the lab the opportunity to compare earlier results and possibly influence their analysis.

- Non-reproducible custody seals were not used.
- Thorough logbooks were not kept before and during field work.

The sampling procedures used by the facility and it's sampling contractors must be corrected before the data collected by the facility can be considered unbiased and representative of the ground water.

F. TASK FORCE DATA COLLECTION/RESULTS

1. Sample Collection Methods

In order to determine the quality of the ground water beneath the facility, selected wells around the RCRA regulated units were sampled. Between April 20 and 23, 1987, EPA sampling contractor, Versar Inc., sampled six facility wells. The list of wells sampled during the investigation, including dates and times of sampling, is provided in Table (1).

The sampling points were selected during a preliminary meeting of State and Task Force personnel. Selection was made based on well location, construction, screen interval, and previous water quality data in order to obtain samples most indicative of potential ground water contamination. The sampling was not meant to establish any releases from the regulated units. Well placement and construction, as well as the existence of solid waste management units in the area, precluded the Task Force from being able to make meaningful determinations of releases from the data.

The wells chosen for this sampling effort include five wells which reach the upper zone of the regional aquifer: two wells upgradient from the industrial wastewater treatment plant (IWWTP) ponds and three wells downgradient from the ponds: The sixth well is screened in the perched zone, upgradient from the ponds.

The wells screened in the regional aquifer are part of a group of 47 M-series wells that were installed into the upper or lower zone of the regional aquifer (Figure 12). The wells were installed in 1981, '82 and '84 as part of the Superfund investigations at the site. Wells M-15 and M-25 represent wells upgradient of the units, and wells M-2B, M-41 and M-9 represent wells downgradient of the units. As mentioned, these wells are not designated as upgradient or downgradient RCRA wells.

Well S-10 was chosen to provide an indication of the water quality in the perched zone (see Figure 9). It was chosen because of the high level of contamination previously found in the well and the likelihood that sufficient water would be present in the well to allow for adequate purging and sampling.

Samples were analyzed for RCRA Indicator Parameters and RCRA Appendix IX parameters (see Appendix A). Samples for organic analysis were sent to EMSI in Camarillo, California; samples for inorganic analysis were sent to Centec in Salem, Virginia; dioxin and furan samples were sent to Compu-Chem in Research Triangle Park, North Carolina; and radionuclide samples were analyzed at Acculabs Research in Wheat Ridge, Colorado.

All the wells were measured prior to purging for depth to the water table. That data is presented in Table 2. The wells were purged using dedicated submersible impeller pumps, with the exception of well S-10 which was purged using a bailer.

Table 1

SAMPLING DATA

WELL #	SAMPLE #	DATE	TIME	METHOD	PARAMETERS COLLECTED
S-10	MQA 870 FAC 29	4/21	17:10 - 18:15	3" Teflon Bailer	VOA(2)*, POC, POX, TOX, Ext. Org. (3), Total metals, Dissolved metals, TOC
S-10	MQA 870 FAC 29	4/22	14:22 - 15:44	"	Ext. Org. (3), Dioxins/Furans (2), Phenols, Cyanide, Anions, Sulfides, Radionuclides (partial).
M-2B	MQA 878 FAC 35	4/23	15:03 - 16:26	Facility's dedicated submersible impeller pump	All
M-9	MQA 872 FAC 31	4/23	10:34 - 11:26	"	All
M-15	MQA 867 FAC 27	4/21	10:40 - 11:30	"	All
M-25	MQA 869 FAC 28	4/21	14:40 - 15:40	"	All
M-41	MQA 871 FAC 32	4/23	9:44 - 12:18	"	All
M-41 (Duplicate)	MQA 876 FAC 34	4/23	9:44 - 12:18	"	All

*Numbers in parentheses indicate the number of sample containers filled.

Reproduced from
best available copy.

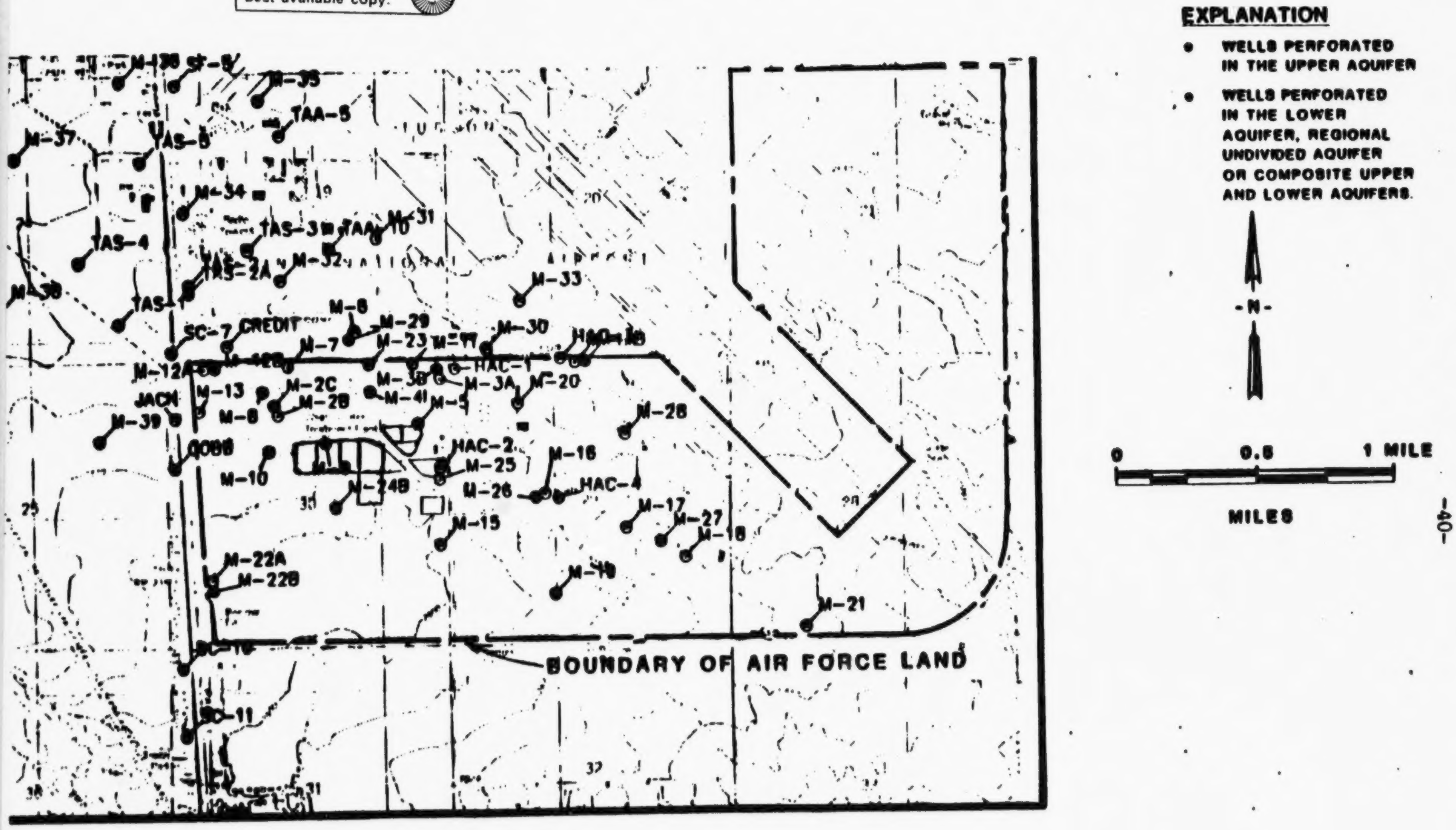

EXPLANATION
● WELLS PERFORATED IN THE UPPER AQUIFER
● WELLS PERFORATED IN THE LOWER AQUIFER, REGIONAL UNDIVIDED AQUIFER OR COMPOSITE UPPER AND LOWER AQUIFERS.
N
0
0.5
1 MILE
MILES
BOUNDARY OF AIR FORCE LAND
M-37
M-38
M-39
M-35
TAA-5
TAS-5
TAS-4
TAS-1
M-34
TAS-3
TAS-2A
M-32
M-31
M-33
SC-7
CREDIT
M-12A
JACK
COBB
M-13
M-8
M-10
M-6
M-7
M-29
M-23
M-2C
M-2B
M-3B
M-41
M-5
M-30
HAC-1
M-3A
M-20
HAC-2
M-25
M-26
M-24B
M-15
M-16
HAC-4
M-28
M-17
M-27
M-18
M-19
M-21
M-22A
M-22B
SC-10
SC-11
25
30
31
32
20
29

Figure 12

LOCATION OF WELLS
SAMPLED IN THE
TUCSON AIRPORT AREA

TUCSON AIRPORT AREA

Table 2

PURGE DATA

WELL #	SAMPLE #	DATE	TIME	DEPTH TO WATER (ft.)	CASING VOLUME (gal.)	PURGE VOLUME (gal.)
S-10	MQA 870 FAC 29	4/21	11:05 - 12:20	95.51	3.4	5
M-2B	MQA 878 FAC 35	4/23	14:25 - 14:37	106.88	56	80
M-9	MQA 872 FAC 31	4/23	9:35 - 10:18	111.93	57.2	175
M-15	MQA 867 FAC 27	4/21	9:00 - 9:30	123.51	30.9	98
M-25	MQA 869 FAC 28	4/21	14:15 - 14:40	117.05	40.9	147
M-41	MQA 871 FAC 32	4/23	8:55 - 9:42	119.68	41.2	150

The submersible pumps were operated by a portable generator. Operation of the generator and hookups to the submersible pumps were conducted by facility employees. Purge water was discharged into 55-gallon drums for measurement and eventual disposal. The purge water was shipped and disposed of as a hazardous waste due to the Superfund off site disposal policy. As the ground waters were known to contain contaminants from a Superfund site and the operations were funded by EPA, it was necessary to dispose of the purge water as a hazardous waste at an acceptable RCRA disposal or treatment facility. USPCI in Utah was selected as the most cost effective disposal facility meeting the requirements of the Superfund off site disposal policy (May 6, 1985 memorandum from Jack McGraw).

The Task Force team attempted to purge three casing volumes of water from each well, if possible. This was achieved on all wells except S-10 and M-2B. Well S-10 was purged to dryness while M-2B was purged of 1.4 casing volumes due to confusion in the reported casing diameter. Casing volumes were calculated using the casing size and the length of the water column. Actual purge volumes are presented in Table 2.

Wells were sampled as soon after purging as possible. A lag time of less than three hours was attempted at all wells. Well S-10 was slow to recover and required that sampling be conducted over a two-day period. At well S-10 some parameters were collected the day of purging and others were collected the following day after recovery (see Table 1).

Sample parameters were collected in priority order as designated in the Sampling Plan with the exception of two wells where the order was altered for well-specific reasons. The list of sample parameters, volumes, containers, and preservation methods are given in priority order of collection in Table 3.

Samples were shipped the same day or the day following collection by next-day delivery Federal Express to the respective labs. Complete details for sample collection, preservation, and shipment are given in the Sampling Plan and Sampling Documentation Report. The reader is referred to the documents for further elaboration on procedures used in the field.

2. Results of Task Force Data

Results of the Task Force data are provided in Table 4. The Task Force data on six sampling points confirmed the identification of a total of five different organic compounds in the Hughes wells. In addition, two unknown hydrocarbons and elevated radionuclides were detected in well S-10.

Table 3: Aliquots and Containers for Water Samples to be Collected at Hughes Aircraft, Tucson, Arizona

rameters	# / Type of Sample Container	Preservation	Comments
latile Organics (VOAs)	2 / 40 ml glass vials teflon septa	Cool, 4°	No Head Space
rgeable Organic Carbon (POC)	1 / 40 ml glass vial teflon septa	Cool, 4°	No Head Space
rgeable Organic Halogens (POX)	1 / 40 ml glass vial tefon septa	Cool, 4°	No Head Space
tractable Organics cid Extractables ase/Neutral Extractables esticides/PCBs erbicides ioxins/Furans	8 / 1 liter amber glass bottles	Cool, 4°	
tals (Total)	1 / 1 liter Polyethylene bottles	HNO_3 to pH<2 Cool, 4°	
tals (Dissolved)	1 / 1 liter Polyethylene bottles	HNO_3 to pH<2 Cool, 4°	Filter prior to preservation
tal Organic Carbon (TOC)	1 / 4 oz glass jar	H_2SO_4 to pH<2 Cool, 4°	
tal Organic Halogens (TOX)	1 / 1 liter amber glass bottle	Cool, 4°	No Head Space
enolics	1 / 1 liter amber glass bottle	H_2SO_4 to pH<2 Cool, 4°	
lfide	1 / 4 oz glass bottle	Zinc Acetate, NaOH Cool, 4°	
yanide	1 / 1 liter Polyethylene bottle	NaOH to pH>12 Cool, 4°	
adionuclides Gross Alpha Gross Beta Radium	1 / 1 gallon Cubetainer or 4 / 1 liter Polyethylene bottles	HNO_3 to pH<2	
ons	1 / 1 liter Polyethylene bottle	Cool, 4°	

Table 4. Summary of Organic and Inorganic Parameters Analyzed from April 1987 Ground Water Task Force Sampling at Hughes Aircraft, AFP 44.

COMPOUND (ppb unless noted)	M-15	M-25	S-10	M-9	M-2B	M-41	M-41 Duplicate	EQUIP BLANK	EQUIP BLANK	FIELD BLANK	TRIP BLANK
					WELL/SAMPLE						
1,1-Dichloroethene			140		22	230	210				
Trans-1,2-Dichloroethene						13					
Trichloroethene		95	1100	79	230	1800	1500				
Caprolactam			20								
1-Hexanol, 2-Ethyl			9								
Unknown Chlorinated Hydrocarbon			8								
Unknown Hydrocarbon			20								
Metals(Total/Dissolved)											
Aluminum			/226		223/		62/	154/	127/		
Barium	/84	/83	/219	/74	99/95	/64	60/64				
Calcium (ppm)	/43.7	/42.3	/102	/50.7	55.7/68.5	/96.3	79.9/96.2				
Chromium			/281	/11	46/37	/69	68/74				
Copper					32/24		8/	16/	17/		
Iron			/81		953/		104/				
Lead					16/5.2		5.1/2.5	6.3/			
Magnesium (ppm)	/9.8	/9.4	/23.4	/11.5	12.4/15	/21.5	17.7/21.2	0.26/	0.29/		
Manganese		/6	/16		29/						
Nickel							30/				
Potassium		/958	/1580		1610/	/984	2400/1370	1180/	1360/		
Sodium (ppm)	/35.3	/36.9	/49.2	/34.9	30.4/38.3	/57	46.3/56.1	0.25/			
Vanadium	/15			/16							/17
Zinc	/577	/423	/455	/369	642/753	/861	717/853	35/	/17		
Indicators											
Chloride (ppm)	6.6	7.5	52	14	22	40	39				
Nitrate Nitrogen	500	500	11000	900	2300	3100	3100				
Sulfate (ppm)	35	32	143	44	76	140	142				
POC	34	40	460	62	110	580	560	54	30	78	48
POX		62	1282		208	1426	1714				
TOC			2300								
TOX			725		268	914	924		16		
pH	7.5	7.0	7.4	7.5	7.1	7.4	7.4				
SpC (um/cm)	400	360	700	390	500	700	700				
Total Radium (pCi/l)	0.1±0.2	0.2±0.3	33±4	0.2±0.2	0.1±0.2	0.2±0.3	0.2±0.3	0.1±0.2	0.0±0.2	-0.1±0.1	
Gross Alpha "	2±2	4±3	180±90	4±3	9±4	7±4	4±4	0±1	1±1	0±1	
Gross Beta "	3±3	4±3	350±90	1±2	4±3	1±3	2±3	0±2	-1±2	-1±2	

Trichloroethene (TCE) and 1,1-dichloroethene (DCE) were found in most wells (which is consistent with CERCLA sampling results). TCE was found in all wells except M-15 ranging in levels from 79 to 1800 ppb. DCE was found in wells S-10, M-2B and M-41 at levels ranging from 22 to 230 ppb. Trans-1,2 dichloroethene was also detected in well M-41.

Well S-10 was found to be the most heavily contaminated well where, in addition to TCE and DCE, Caprolactam (20 ppb), 1-Hexanol, 2-Ethyl (9 ppb) and two unknown hydrocarbons were detected. Levels of metals and many indicator parameters were also higher in S-10 than surrounding regional aquifer wells. Radionuclide levels in well S-10 were dramatically higher than all other wells sampled. Total radium was reported at 33±4 pCi/l, gross alpha was reported at 180±90 pCi/l, and gross beta was reported at 350±90 pCi/l. These levels of radionuclides were two orders of magnitude higher than surrounding wells. It cannot be determined if these levels are naturally occuring or reflect some unknown source. Levels of barium, chromium, and nitrate nitrogen were also elevated in well S-10. Dissolved barium was reported at 219 ppb, dissolved chromium was reported at 281 ppb, and nitrate nitrogen was reported at 11,000 ppb.

REFERENCES

Project Plan, Hazardous Waste Ground Water Task Force, Hughes Aircraft, U.S. Air Force Plant #44, Tucson, Arizona. Mark Filippini and Donn Zuroski, USEPA Region 9, April 1987.

Ground Water Sampling Plan, Hughes Aircraft, U.S. Air Force Plant #44, Tucson, Arizona, Frances Schultz, USEPA Region 9, April 1987.

Ground Water Sampling Audit Report, Hughes Aircraft, Tucson, Arizona, Frances Schultz, USEPA Region 9, April 1988.

Sampling and Documentation Report, Hughes Aircraft Company, Tucson, Arizona, Frances Schultz, USEPA Region 9, October 1987.

Installation Restoration Program Phase I--Records Search, Air Force Plant 44, Tucson, Arizona, Science Applications International Corp., October 1985

Annual Static Water Level Basic Data Report, Tucson Basin and Avra Valley, Pima County, Arizona, City of Tucson, Tucson Water, Planning Division, 1981

Results of the Tucson Airport Area Remedial Investigation, Phase I, Volume I, Summary Report, Arizona Department of Health Services, Phoenix, Arizona September 1985

Results of the Tucson Airport Area Remedial Investigation, Phase I, Volume II, Contaminant Transport Modeling, Arizona Department of Water Resources, Hydrology Division, November 1985

Distribution and Movement of Trichloroethylene in Ground Water in the Tucson Area, Arizona, U.S. Geological Survey, Water-Resources Investigations Report 86-4313

Summary of 1986 Hydrologic Monitoring Program, U.S. Air Force Plant No. 44, Tucson, Arizona, Volume I, Hargis and Associates Inc., June 1987

Phase I Investigation of Subsurface Conditions in the Vicinity of Abandoned Waste Disposal Sites, Hughes Aircraft Company Manufacturing Facility Tucson, Arizona, Volume I, Hargis and Montgomery, Inc., January 1982

Phase II Investigation of Sublurface Conditions in the Vicinity of Abandoned Waste Disposal Sites, Hughes Aircraft Company Manufacturing Facility Tucson, Arizona, Volume I, Hargis and Montgomery, Inc., March 1982

Draft Remedial Action Plan, United States Air Force Plant No. 44, Tucson, Arizona, April 10, 1985

APPENDIX A

Analytical Parameters

RCRA INDICATOR PARAMETERS

Anions
Phenols
TOC
TOX
POC
POX
Metals - Dissolved
Metals - Total
Cyanide
Radium
Gross Alpha
Gross Beta
Turbidity
Specific Conductance
pH

Reproduced from
best available copy.

APPENDIX IX -- GROUND-WATER MONITORING LIST

Systematic Name	CAS RN	Common Name
Acenaphthylene	208-96-8	Acenaphthalene
Acenaphthylene, 1,2-dihydro-	83-32-9	Acenaphthene
Acetamide, N-(4-ethoxyphenyl)-	62-44-2	Phenacetin
Acetamide, N-9H-fluoren-2-yl-	53-96-3	2-Acetylaminofluorene
Acetic acid ethenyl ester	108-05-4	Vinyl acetate
Acetic acid, (2,4,5-trichlorophenoxy)-	93-76-5	2,4,5-T
Acetic acid, (2,4-dichlorophenoxy)-	94-75-7	2,4-Dichlorophenoxyacetic acid
Acetonitrile	75-05-8	Acetonitrile
Aluminum	7429-90-5	Aluminum (total)
Anthracene	120-12-7	Anthracene
Antimony	7440-36-0	Antimony (total)
Aroclor 1016	12674-11-2	Aroclor 1016
Aroclor 1221	11104-28-2	Aroclor 1221
Aroclor 1232	11141-16-5	Aroclor 1232
Aroclor 1242	53469-21-9	Aroclor 1242
Aroclor 1248	12672-29-6	Aroclor 1248

APPENDIX IX -- GROUND-WATER MONITORING LIST

Systematic Name	CAS RN	Common Name
Aroclor 1254	11097-69-1	Aroclor 1254
Aroclor 1260	11096-82-5	Aroclor 1260
Arsenic	7440-38-2	Arsenic (total)
Barium	7440-39-3	Barium (total)
Benz[a]anthracene, 7,12-dimethyl-	57-97-6	7,12-Dimethylbenz[a]anthracene
Benz[j]aceanthrylene, 1,2-dihydro-3-methyl-	56-49-5	3-Methylcholanthrene
Benz[e]acephenanthrylene	205-99-2	Benzo[b]fluoranthene
Benzamide, 3,5-dichloro-N-(1,1-dimethyl-2-propynyl)-	23950-58-5	Pronamide
Benz[a]anthracene	56-55-3	Benz[a]anthracene
Benzenamine	62-53-3	Aniline
Benzenamine, 2-methyl-5-nitro-	99-55-8	5-Nitro-o-toluidine
Benzenamine, 2-nitro-	88-74-4	2-Nitroaniline
Benzenamine, 3-nitro-	99-09-2	3-Nitroaniline
Benzenamine, 4-chloro-	106-47-8	p-Chloroaniline
Benzenamine, 4-nitro-	100-01-6	p-Nitroaniline
Benzenamine, 4,4'-methylenebis[2-chloro-	101-14-4	4,4'-Methylenebis(2-chloroaniline)

May 15, 1986

APPENDIX IX -- GROUND-WATER MONITORING LIST

Systematic Name	CAS RN	Common Name
Benzenamine, N-nitroso-N-phenyl-	86-30-6	N-Nitrosodiphenylamine
Benzenamine, N-phenyl-	122-39-4	Diphenylamine
Benzenamine, N,N-dimethyl-4-(phenylazo)-	60-11-7	p-Dimethylaminoazobenzene
Benzene	71-43-2	Benzene
Benzene, 1-bromo-4-phenoxy-	101-55-3	4-Bromophenyl phenyl ether
Benzene, 1-chloro-4-phenoxy-	7005-72-3	4-Chlorophenyl phenyl ether
Benzene, 1-methyl-2,4-dinitro-	121-14-2	2,4-Dinitrotoluene
Benzene, 1,1'-(2,2,2-trichloroethylidene)bis(4-chloro-	50-29-3	DDT
Benzene, 1,1'-(2,2,2-trichloroethylidene)bis(4-methoxy-	72-43-5	Methoxychlor
Benzene, 1,1'-(2,2-dichloroethylidene)bis(4-chloro-	72-54-8	DDD
Benzene, 1,1'-(dichloroethenylidene)bis(4-chloro-	72-55-9	DDE
Benzene, 1,2-dichloro-	95-50-1	o-Dichlorobenzene
Benzene, 1,2,4-trichloro-	120-82-1	1,2,4-Trichlorobenzene
Benzene, 1,2,4,5-tetrachloro-	95-94-3	1,2,4,5-Tetrachlorobenzene
Benzene, 1,3-dichloro-	541-73-1	m-Dichlorobenzene
Benzene, 1,4-dichloro-	106-46-7	p-Dichlorobenzene

APPENDIX IX -- GROUND-WATER MONITORING LIST

Systematic Name	CAS RN	Common Name
Benzene, 1,4-dinitro-	100-25-4	meta-Dinitrobenzene
Benzene, 2-methyl-1,3-dinitro-	606-20-2	2,6-Dinitrotoluene
Benzene, chloro-	108-90-7	Chlorobenzene
Benzene, dimethyl-	1330-20-7	Xylene (total)
Benzene, ethenyl-	100-42-5	Styrene
Benzene, ethyl-	100-41-4	Ethyl benzene
Benzene, hexachloro-	118-74-1	Hexachlorobenzene
Benzene, methyl-	108-88-3	Toluene
Benzene, nitro-	98-95-3	Nitrobenzene
Benzene, pentachloro-	608-93-5	Pentachlorobenzene
Benzene, pentachloronitro-	82-68-8	Pentachloronitrobenzene
Benzeneacetic acid, 4-chloro-α-(4-chlorophenyl)-α-hydroxy-, ethyl ester	510-15-6	Chlorobenzilate
1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester	117-81-7	Bis(2-ethylhexyl) phthalate
1,2-Benzenedicarboxylic acid, butyl phenylmethyl ester	85-68-7	Butyl benzyl phthalate
1,2-Benzenedicarboxylic acid, dibutyl ester	84-74-2	Di-n-butyl phthalate

Reproduced from
best available copy.

APPENDIX IX -- GROUND-WATER MONITORING LIST

53

Systematic Name	CAS RN	Common Name
1,2-Benzenedicarboxylic acid, diethyl ester	84-66-2	Diethyl phthalate
1,2-Benzenedicarboxylic acid, dimethyl ester	131-11-3	Dimethyl phthalate
1,2-Benzenedicarboxylic acid, dioctyl ester	117-84-0	Di-n-octyl phthalate
1,3-Benzenediol	108-46-3	Resorcinol
Benzeneethanamine, α,α-dimethyl-	122-09-8	alpha,alpha-Dimethylphenethylamine
Benzenemethanol	100-51-6	Benzyl alcohol
Benzenethiol	108-98-5	Benzenethiol
1,3-Benzodioxole, 5-(1-propenyl)-	120-58-1	Isosafrole
1,3-Benzodioxole, 5-(2-propenyl)-	94-59-7	Safrole
Benzo[k]fluoranthene	207-08-9	Benzo[k]fluoranthene
Benzoic acid	65-85-0	Benzoic acid
Benzo[rst]pentaphene	189-55-9	Dibenz[a,i]pyrene
Benzo[ghi]perylene	191-24-2	Benzo[ghi]perylene
Benzo[a]pyrene	50-32-8	Benzo[a]pyrene
Beryllium	7440-41-7	Beryllium (total)
[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dichloro-	91-94-1	3,3'-Dichlorobenzidine

APPENDIX IX -- GROUND-WATER MONITORING LIST

Systematic Name	CAS RN	Common Name
[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethoxy-	119-90-4	3,3'-Dimethoxybenzidine
[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethyl-	119-93-7	3,3'-Dimethylbenzidine
[1,1'-Biphenyl]-4-amine	92-67-1	4-Aminobiphenyl
[1,1'-Biphenyl]-4,4'-diamine	92-87-5	Benzidine
1,3-Butadiene, 1,1,2,3,4,4-hexachloro-	87-68-3	Hexachlorobutadiene
1,3-Butadiene, 2-chloro-	126-99-8	2-Chloro-1,3-butadiene
1-Butanamine, N-butyl-N-nitroso-	924-16-3	N-Nitrosodi-n-butylamine
2-Butanone	78-93-3	Methyl ethyl ketone
2-Butene, 1,4-dichloro-, (E)-	110-57-6	trans-1,4-Dichloro-2-butene
Cadmium	7440-43-9	Cadmium (total)
Calcium	7440-70-2	Calcium (total)
Carbon disulfide	75-15-0	Carbon disulfide
Chromium	7440-47-3	Chromium (total)
Chrysene	218-01-9	Chrysene
Cobalt	7440-48-4	Cobalt (total)
Copper	7440-50-8	Copper (total)

APPENDIX IX -- GROUND-WATER MONITORING LIST

Systematic Name	CAS RN	Common Name
Cyanide	57-12-5	Cyanide
2,5-Cyclohexadiene-1,4-dione	106-51-4	p-Benzoquinone
Cyclohexane, 1,2,3,4,5,6-hexachloro-, (1α,2α,3β,4α,5β,6β)-	319-84-6	alpha-BHC
Cyclohexane, 1,2,3,4,5,6-hexachloro-, (1α,2β,3α,4β,5α,6β)-	319-85-7	beta-BHC
Cyclohexane, 1,2,3,4,5,6-hexachloro-, (1α,2α,3α,4β,5α,6β)-	319-86-8	delta-BHC
Cyclohexane, 1,2,3,4,5,6-hexachloro-, (1α,2α,3β,4α,5α,6β)-	58-89-9	gamma-BHC
2-Cyclohexen-1-one, 3,5,5-trimethyl-	78-59-1	Isophorone
1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-	77-47-4	Hexachlorocyclopentadiene
Dibenz[a,h]anthracene	53-70-3	Dibenz[a,h]anthracene
Dibenzo[b,e][1,4]dioxin, 2,3,7,8-tetrachloro-	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin
		Hexachlorodibenzo-p-dioxins
		Pentachlorodibenzo-p-dioxins
		Tetrachlorodibenzo-p-dioxins
Dibenzo[b,def]chrysene	189-64-0	Dibenzo[a,h]pyrene
Dibenzofuran	132-64-9	Dibenzofuran
		Hexachlorodibenzofurans

APPENDIX IX -- GROUND-WATER MONITORING LIST

Systematic Name	CAS RN	Common Name
		Pentachlorodibenzofurans
		Tetrachlorodibenzofurans
2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aα,2β,2aα,3β,6β,6aα,7β,7aα)-	60-57-1	Dieldrin
2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aα,2β,2aβ,3α,6α,6aβ,7β,7aα)-	72-20-8	Endrin
1,4:5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, (1α,4α,4aβ,5α,8α,8aβ)-	309-00-2	Aldrin
1,4:5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, (1α,4α,4aβ,5β,8β,8aβ)-	465-73-6	Isodrin
1,4-Dioxane	123-91-1	1,4-Dioxane
Ethanamine, N-ethyl-N-nitroso-	55-18-5	N-Nitrosodiethylamine
Ethanamine, N-methyl-N-nitroso-	10595-95-6	N-Nitrosomethylethylamine
Ethane, 1,1-dichloro-	75-34-3	1,1-Dichloroethane
Ethane, 1,1'-[methylenebis(oxy)]bis[2-chloro-	111-91-1	Bis(2-chloroethoxy)methane
Ethane, 1,1'-oxybis[2-chloro-	111-44-4	Bis(2-chloroethyl) ether
Ethane, 1,1,1-trichloro-	71-55-6	1,1,1-Trichloroethane
Ethane, 1,1,1,2-tetrachloro-	630-20-6	1,1,1,2-Tetrachloroethane

Reproduced from
best available copy.

APPENDIX IX -- GROUND-WATER MONITORING LIST

Systematic Name	CAS RN	Common Name
Ethane, 1,1,2-trichloro-	79-00-5	1,1,2-Trichloroethane
Ethane, 1,1,2,2-tetrachloro-	79-34-5	1,1,2,2-Tetrachloroethane
Ethane, 1,2-dibromo-	106-93-4	1,2-Dibromoethane
Ethane, 1,2-dichloro-	107-06-2	1,2-Dichloroethane
Ethane, chloro-	75-00-3	Chloroethane
Ethane, hexachloro-	67-72-1	Hexachloroethane
Ethane, pentachloro-	76-01-7	Pentachloroethane
1,2-Ethanediamine, N,N-dimethyl-N'-2-pyridinyl-N'-(2-thienylmethyl)-	91-80-5	Methapyrilene
Ethanone, 1-phenyl-	98-86-2	Acetophenone
Ethene, (2-chloroethoxy)-	110-75-8	2-Chloroethyl vinyl ether
Ethene, 1,1-dichloro-	75-35-4	1,1-Dichloroethylene
Ethene, 1,2-dichloro-, (E)-	156-60-5	trans-1,2-Dichloroethene
Ethene, chloro-	75-01-4	Vinyl chloride
Ethene, tetrachloro-	127-18-4	Tetrachloroethene
Ethene, trichloro-	79-01-6	Trichloroethene
Fluoranthene	206-44-0	Fluoranthene

APPENDIX IX -- GROUND-WATER MONITORING LIST

Systematic Name	CAS RN	Common Name
Fluoride	16984-48-8	Fluoride
9H-Fluorene	86-73-7	Fluorene
2-Hexanone	591-78-6	2-Hexanone
Hydrazine, 1,2-diphenyl-	122-66-7	1,2-Diphenylhydrazine
Indeno(1,2,3-cd)pyrene	193-39-5	Indeno(1,2,3-cd)pyrene
Iron	7439-89-6	Iron (total)
Lead	7439-92-1	Lead (total)
Magnesium	7439-95-4	Magnesium (total)
Manganese	7439-96-5	Manganese (total)
Mercury	7439-97-6	Mercury (total)
Methanamine, N-methyl-N-nitroso-	62-75-9	N-Nitrosodimethylamine
Methane, bromo-	74-83-9	Bromomethane
Methane, bromodichloro-	75-27-4	Bromodichloromethane
Methane, chloro-	74-87-3	Chloromethane
Methane, dibromo-	74-95-3	Dibromomethane
Methane, dibromochloro-	124-48-1	Chlorodibromomethane

APPENDIX IX -- GROUND-WATER MONITORING LIST

Systematic Name	CAS RN	Common Name
Methane, dichloro-	75-09-2	Dichloromethane
Methane, dichlorodifluoro-	75-71-8	Dichlorodifluoromethane
Methane, iodo-	74-88-4	Iodomethane
Methane, tetrachloro-	56-23-5	Carbon tetrachloride
Methane, tribromo-	75-25-2	Tribromomethane
Methane, trichloro-	67-66-3	Chloroform
Methane, trichlorofluoro-	75-69-4	Trichloromonofluoromethane
Methanesulfonic acid, methyl ester	66-27-3	Methyl methanesulfonate
Methanethiol, trichloro-	75-70-7	Trichloromethanethiol
4,7-Methano-1H-indene, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-	57-74-9	Chlordane
4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-	76-44-8	Heptachlor
2,5-Methano-2H-indeno[1,2-b]oxirene, 2,3,4,5,6,7,7-heptachloro-1a,1b,5,5a,6,6a-hexahydro-, (1aα,1bβ,2α,5α,5aβ,6β,6aα)-	1024-57-3	Heptachlor epoxide
6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide, (3α,5aβ,6α,9α,9aβ)-	959-98-8	Endosulfan I
6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide, (3α,5aα,6β,9β,9aα)-	33213-65-9	Endosulfan II

APPENDIX IX -- GROUND-WATER MONITORING LIST

Systematic Name	CAS RN	Common Name
1,3,4-Metheno-2H-cyclobuta[cd]pentalen-2-one, 1,1a,3,3a,4,5,5,5a, 5b,6-decachlorooctahydro-	143-50-0	Kepone
1,2,4-Methenocyclopenta[cd]pentalene-5-carboxaldehyde, 2,2a,3,3,4, 7-hexachlorodecahydro-, (1α,2β,2aβ,4β,4aβ,5β,6aβ,6bβ, 7R*)-	7421-93-4	Endrin aldehyde
Morpholine, 4-nitroso-	59-89-2	N-Nitrosomorpholine
1-Naphthalenamine	134-32-7	1-Naphthylamine
2-Naphthalenamine	91-59-8	2-Naphthylamine
Naphthalene	91-20-3	Naphthalene
Naphthalene, 2-chloro-.	91-58-7	2-Chloronaphthalene
Naphthalene, 2-methyl-	91-57-6	2-Methylnaphthalene
1,4-Naphthalenedione	130-15-4	1,4-Naphthoquinone
Naphtho[1,2,3,4-def]chrysene	192-65-4	Dibenzo[a,e]pyrene
Nickel	7440-02-0	Nickel (total)
Osmium	7440-04-2	Osmium (total)
Oxirane	75-21-8	Ethylene oxide
2-Pentanone, 4-methyl-	108-10-1	4-Methyl-2-pentanone
Phenanthrene	85-01-8	Phenanthrene

APPENDIX IX -- GROUND-WATER MONITORING LIST

Reproduced from best available copy.

Systematic Name	CAS RN	Common Name
Phenol	108-95-2	Phenol
Phenol, 2-(1-methylpropyl)-4,6-dinitro-	88-85-7	2-sec-Butyl-4,6-dinitrophenol
Phenol, 2-chloro-	95-57-8	2-Chlorophenol
Phenol, 2-methyl-	95-48-7	ortho-Cresol
Phenol, 2-methyl-4,6-dinitro-	534-52-1	4,6-Dinitro-o-cresol
Phenol, 2-nitro-	88-75-5	2-Nitrophenol
Phenol, 2,2'-methylenebis[3,4,6-trichloro-	70-30-4	Hexachlorophene
Phenol, 2,3,4,6-tetrachloro-	58-90-2	2,3,4,6-Tetrachlorophenol
Phenol, 2,4-dichloro-	120-83-2	2,4-Dichlorophenol
Phenol, 2,4-dimethyl-	105-67-9	2,4-Dimethylphenol
Phenol, 2,4-dimethyl-	105-67-9	2,4-Dimethylphenol
Phenol, 2,4-dinitro-	51-28-5	2,4-Dinitrophenol
Phenol, 2,4,5-trichloro-	95-95-4	2,4,5-Trichlorophenol
Phenol, 2,4,6-trichloro-	88-06-2	2,4,6-Trichlorophenol
Phenol, 2,6-dichloro-	87-65-0	2,6-Dichlorophenol
Phenol, 4-chloro-3-methyl-	59-50-7	p-Chloro-m-cresol

APPENDIX IX -- GROUND-WATER MONITORING LIST

Systematic Name	CAS RN	Common Name
Phenol, 4-methyl-	106-44-5	para-Cresol
Phenol, 4-nitro-	100-02-7	4-Nitrophenol
Phenol, pentachloro-	87-86-5	Pentachlorophenol
Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester	298-02-2	Phorate
Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester	298-04-4	Disulfoton
Phosphorothioic acid, O-[4-[(dimethylamino)sulfonyl]phenyl] O,O-dimethyl ester	52-85-7	Famphur
Phosphorothioic acid, O,O-diethyl O-(4-nitrophenyl) ester	56-38-2	Parathion
Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester	297-97-2	O,O-Diethyl O-2-pyrazinyl phosphorothioate
Phosphorothioic acid, O,O-dimethyl O-(4-nitrophenyl) ester	298-00-0	Methyl parathion
Piperidine, 1-nitroso-	100-75-4	N-Nitrosopiperidine
Potassium	7440-09-7	Potassium (total)
1-Propanamine, N-nitroso-N-propyl-	621-64-7	Di-n-propylnitrosamine
Propane, 1,2-dibromo-3-chloro-	96-12-8	1,2-Dibromo-3-chloropropane
Propane, 1,2-dichloro-	78-87-5	1,2-Dichloropropane
Propane, 1,2,3-trichloro-	96-18-4	1,2,3-Trichloropropane

APPENDIX IX -- GROUND-WATER MONITORING LIST

Systematic Name	CAS RN	Common Name
Propane, 2,2'-oxybis[1-chloro-	108-60-1	Bis(2-chloroisopropyl) ether
Propanedinitrile	109-77-3	Malononitrile
Propanenitrile	107-12-0	Ethyl cyanide
Propanenitrile, 3-chloro-	542-76-7	3-Chloropropionitrile
Propanoic acid, 2-(2,4,5-trichlorophenoxy)-	93-72-1	Silvex
1-Propanol, 2,3-dibromo-, phosphate (3:1)	126-72-7	Tris(2,3-dibromopropyl) phosphate
1-Propanol, 2-methyl-	78-83-1	Isobutyl alcohol
2-Propanone	67-64-1	Acetone
2-Propenal	107-02-8	Acrolein
1-Propene, 1,1,2,3,3,3-hexachloro-	1888-71-7	Hexachloropropene
1-Propene, 1,3-dichloro-, (E)-	10061-02-6	trans-1,3-Dichloropropene
1-Propene, 1,3-dichloro-, (Z)-	10061-01-5	cis-1,3-Dichloropropene
1-Propene, 3-chloro-	107-05-1	3-Chloropropene
2-Propenenitrile, 2-methyl-	126-98-7	Methacrylonitrile
2-Propenenitrile	107-13-1	Acrylonitrile
2-Propenoic acid, 2-methyl-, ethyl ester	97-63-2	Ethyl methacrylate

APPENDIX IX -- GROUND-WATER MONITORING LIST

Reproduced from
best available copy.

Systematic Name	CAS RN	Common Name
2-Propenoic acid, 2-methyl-, methyl ester	80-62-6	Methyl methacrylate
2-Propen-1-ol	107-18-6	Allyl alcohol
2-Propyn-1-ol	107-19-7	2-Propyn-1-ol
Pyrene	129-00-0	Pyrene
Pyridine	110-86-1	Pyridine
Pyridine, 2-methyl-	109-06-8	2-Picoline
Pyrrolidine, 1-nitroso-	930-55-2	N-Nitrosopyrrolidine
Selenium	7782-49-2	Selenium (total)
Silver	7440-22-4	Silver (total)
Sodium	7440-23-5	Sodium (total)
Sulfide	18496-25-8	Sulfide
Sulfurous acid, 2-chloroethyl 2-[4-(1,1-dimethylethyl)phenoxy]-1-methylethyl ester	140-57-8	Aramite
Thallium	7440-28-0	Thallium (total)
Thiodiphosphoric acid ($[(HO)_2P(S)]_2O$), tetraethyl ester	3689-24-5	Tetraethyldithiopyrophosphate
Tin	7440-31-5	Tin (total)

APPENDIX IX -- GROUND-WATER MONITORING LIST

Systematic Name	CAS RN	Common Name
Toxaphene	8001-35-2	Toxaphene
Vanadium	7440-62-2	Vanadium (total)
Zinc	7440-66-6	Zinc (total)

APPENDIX B

Review of Neutrom Probe System at Hughes Aircraft

Report from Environmental Monitoring Systems
Laboratory - Las Vegas

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
ENVIRONMENTAL MONITORING SYSTEMS LABORATORY-LAS VEGAS
P.O. BOX 93478
LAS VEGAS, NEVADA 89193-3478
(702/798-2100 · FTS 545-2100)

DEC 22 1987

SUBJECT: Review of Neutron Probe System at Hughes Aicraft Facility

FROM: Aldo T. Mazzella for
Geophysicist
Aquatic and Subsurface Monitoring Branch
Advanced Monitoring Systems Division

TO: Donn Zuroski
Field Operations Branch
Toxics and Waste Management Division
Region 9

I have reviewed the five reports on the Neutron Probe Monitoring System for moisture detection at the Hughes Aircraft facility and have discussed them with Eric N. Koglin, a hydrologist in our Branch. My review comments are attached.

Attachment

68

Review of Neutron Probe System for Hughes Aircraft Facility, Tucson, Arizona

I have reviewed the following five reports on the neutron probe system for the Hughes Aircraft facility:

1) "Construction and Testing of Pilot Neutron Logging System Hughes Aircraft Company Manufacturing Facility Tucson, Arizona," December 18, 1981;

2) "Results of Additional Testing Pilot Neutron Logging System Hughes Aircraft Company Manufacturing Facility Tucson, Arizona," April 19,1982;

3) "Results of Construction and Testing of Neutron Logging System Hughes Aircraft Company Manufacturing Facility Tucson, Arizona," March 3,1983;

4) "Evaluation of 1983 Quarterly Neutron Logs, U.S. Air Force Plant No.44," June 22, 1984;

5) "Results of Quarterly Neutron Logging January 1987 Hughes Aircraft Company Tucson, Arizona," February 9, 1987.

My comments on the system can be divided into two separate areas, one addresses the sensitivity of the neutron probe in the well completion configuration, and the other area addresses the spatial variability of the well locations and their ability to detect lateral movement of fluids in the vadose zone.

One of the most important questions that the reports fail to address is the sensitivity of the neutron probe when it is used in the wells at the Hughes Aircraft facility. A conversion of the count rate to moisture content is not presented. I plotted some of the data from report #2 of neutron counts verses moisture content measured from core samples. This is shown in Figure 1. Thirty-one points are plotted from wells N-1 and N-5. With the exception of four points at the highest moisture content, 21% and above, the counts and core moisture content do not appear to be very well correlated. Figure 2 shows a similar plot for well N-14 for January 26,1983, from report #3. Fifteen points are plotted. The correlation appears to be better, however, there still appears to be some scatter and outlier points.

The wells were completed with a .2 inch thick steel wall casing and a 1.125 inch thick cement grout in the annulus. The cement was about 33% water by weight. This is not an optimum well completion method for a neutron probe moisture monitoring system. According to L.G. Wilson, 1980, "The results of field studies by Halpenny (personal communication, 1979) showed that bound water within grout markedly attenuates the flux of fast neutrons from a source. Consequently, the sensitivity of a logger in detecting water content changes in the surrounding formations is correspondingly reduced." Based on this, it would seem imperative that the radius of investigation and sensitivity of the combined probe-well configuration should be established. The sensitivity for detecting changes in the moisture content should be evaluated for the different formations and moisture content levels.

An additional consideration is that the neutron moisture logs only indicate the water content of the soils. According to L.G. Wilson, 1980, "Water may move through a specific subsurface horizon without causing a change in storage. Consequently, a neutron log may not manifest water movement in this case." (See also Everett et al. 1984). The change in water content in the various formations should be determined under dynamic conditions with different levels of water flow. Since all the monitoring wells were not in place before the evaporation ponds, one does not know the pre-pond background conditions and whether the existing log moisture contents may be reflecting an existing long term leak.

The initial work done at well N-1 is of interest and concern. This was a percolation test with a 700 gallons per day leak. "No apparent moisture increases have been observed in neutron logging hole N-1." (reference #4 above). A number of conclusions and recommendations were made in report #4 to address this problem. Was this work conducted? I found no further reports discussing this problem.

A number of pieces of information are not available in the reports. Is the neutron probe an axial symmetric or decentralized tool, what was the detector, and what is the diameter of the tool? This information would be useful to help evaluated the system and the reproducibility of the measurements. Some of the reproducibility questions are answered in the last report of February 9, 1987, where various rate effects are evaluated. However, the above questions should be answered.

The present system relies upon the existence of continuous layers of clay and caliche to produce lateral movement in the vadose zone of any leak. The continuity of these layers has not been established, nor has any direction been suggested for this lateral movement. Is it assumed to be isotropic? Many core logs were taken, however, there is not any discussion about the continuity between the logs. No surface elevations were given for the wells, and so I did not attempt to draw any cross sections. The distance between the monitoring wells is on the order of 200 to 400 feet. Without establishing a direction of flow in the perched zones, one must be concerned about missing a leak because of the spatial location of the wells. Some modelling of unsaturated zone flow is needed to provide a leak detection confidence level for the monitoring well network system.

In report #4, increased moisture content is observed in holes N-23 and N-24 at a depth of about 30 feet. This is attributed to lateral movement of water from an arroyo due to "record breaking rainfalls." The distance of the arroyo is indicated as "immediately north of neutron logging holes N-23 and N-24." This distance should be specified. No moisture increases were indicated in neutron hole N-22, about 100 feet to the south of wells N-23 and N-24. One should be concerned and at least provide an explanation for why this moisture was not observable at N-22 and possibly other holes, such as N-12, 13, 14, 19, and 21. If a significant amount of water observed at N-23 and N-24 did not reach N-22, 100 feet away, then, since the ponds are over 200 feet across, is it equally possible that a leak in the ponds would not reach holes N-23 and N-24?

Conclusions

There are a number of aspects of the neutron probe borehole configuration that need to be investigated before the system could be considered acceptable for a leak detection monitoring network. These are:

(1) The sensitivity of the neutron probe in the borehole for detecting changes in the moisture content should be evaluated for the different formations and moisture content levels. In particular, the effects of the casing material and grout on the probe sensitivity and detectability

should be evaluated.

(2) It should be established that no leaks existed from the ponds before the monitoring of the wells was initiated. The change in water content of the various formations should be determined under dynamic conditions with different levels of water flow.

(3) The continuity of the clay or caliche layers throughout the pond area must be established.

(4) Some modelling of unsaturated zone flow is needed to provide a leak detection confidence level for the monitoring well network system.

Unless the results of the above items prove conclusively that a leak from any area of the ponds reaches the edges and is detectable, this neutron probe system is not acceptable as a stand alone monitoring network. Consideration should be given to other methods, including other surface geophysical and cross borehole geophysical methods, such as described by Peters et al. (1982), and EarthTech Corporation (1981).

References:

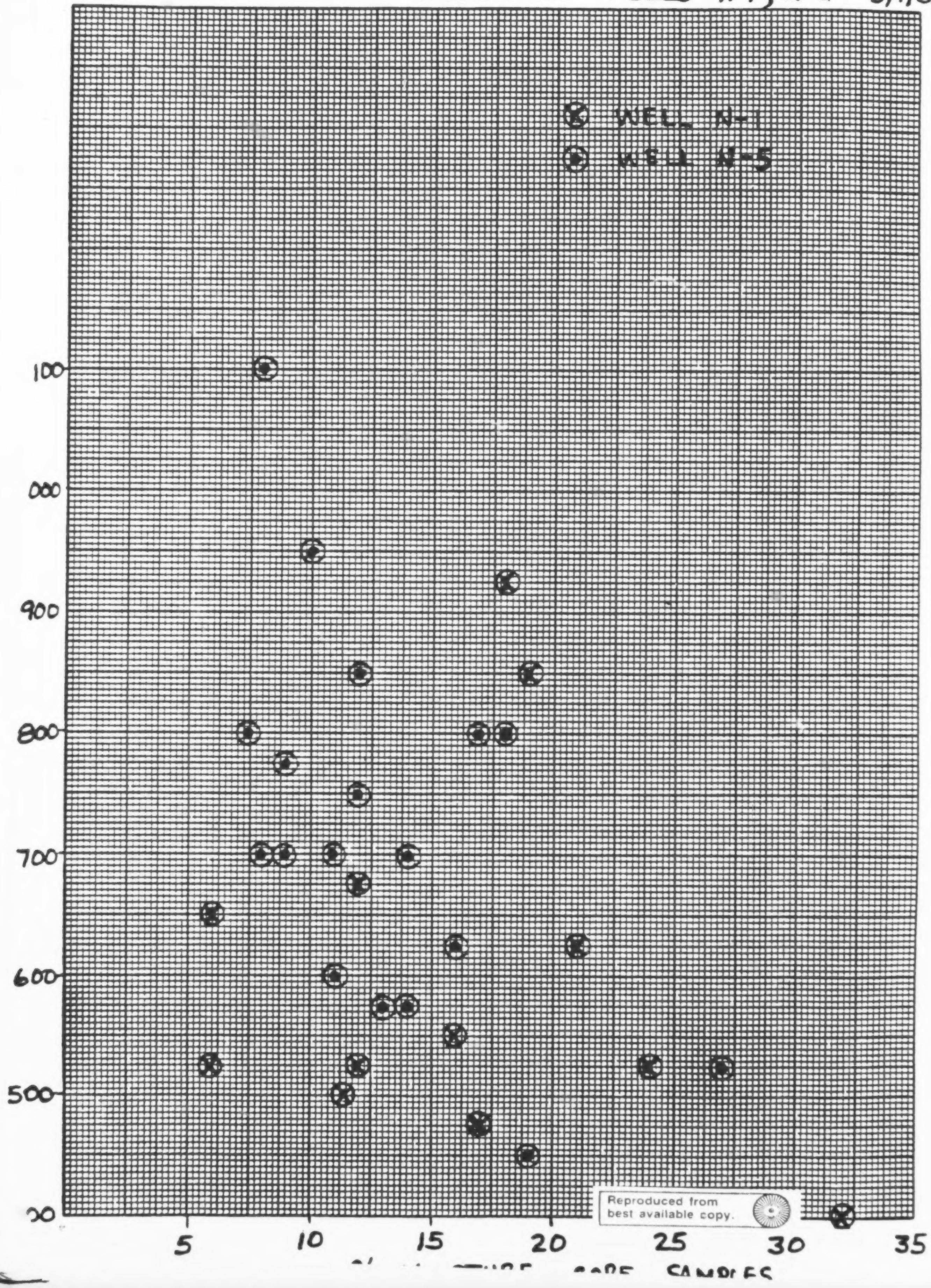
Wilson, L.G., June 1980, "Monitoring in the Vadose Zone: A Review of Technical Elements and Methods", EPA-600/7-80-134, U.S. Environmental Protection Agency, Las Vegas, Nevada.

Everett, L.G., Wilson, L.G., and Hoylman,E.W., 1984, "Vadose Zone Monitoring for Hazardous Waste Sites", Noyes Data Corporation, Park Ridge, New Jersey.

Peters, W.E., Schultz, D.W., and Duff, R.M., 1982, Electrical Resistivity Techniques for Locating Liner Leaks, EPA project report, Municipal Environmental Research Laboratory, Cincinnati, Ohio.

EarthTech Research Corporation, 1981, Assessment of Innovative Techniques to Detect Landfill Liner Failings, EPA project report, Cincinnati, Ohio.

FIGURE 1. WELLS N-1, N-5 3/9/82



Reproduced from best available copy.

FIGURE 2. WELL N H [illegible]